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ONE-HUNDRED-AND-NINETY-THIRD SESSION, 1946-47

PATRON—HIS MAJESTY THE KING

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N.B.—For purposes of reference, a list of Standing Committees for the year 1946-47 *will be found on pp.* 17-19 *of this issue.*

MEETINGS OF THE SOCIETY

The following meetings of the Society will take place in coming weeks :

Ordinary Meetings

Wednesday, November 27th, at 5 p.m. (Cobb Lecture).—"The Documentary Film". By Sir Stephen Tallents, K.C.M.G., C.B., C.B.E. The Rt. Hon. L. S. Amery, C.H., in the Chair.

Wednesday, December 4th, at 5 p.m. (Sir William Jackson Pope Memorial Lecture).—"Sir William Jackson Pope: His Influence on Scientific Organisation". By L. H. Lampitt, D.Sc., F.R.I.C., President of the Society of Chemical Industry. E. K. Rideal, M.A., D.Sc., Ph.D., F.R.S., Fullerian Professor of Chemistry, Royal Institution, and Director, Davy Faraday Research Laboratory, in the Chair.

India and Burma Section

Thursday, December 5th, at 2.30 p.m.—"Some Supply Aspects of Rehabilitation in Post-war Burma". By A. H. Seymour, C.B.E., M.A., I.C.S. Sir Gilbert Laithwaite, K.C.I.E., C.S.I., Deputy Under-Secretary of State for Burma, in the Chair. (Joint meeting with the East India Association).

Thomas Gray Trust Lectures

Mondays, December 2nd and 9th, at 5 p.m.—"Marine Life-saving Appliances for the Merchant Navy and Fishing Fleets". By Captain J. C. Taylor, Principal Officer, Marine Surveyors' Office, Ministry of Transport.

Syllabus. Lecture I. Ships' lifeboats, their classification, construction, equipment and stowage. Life-rafts.

Lecture II. Buoyant apparatus, lifebuoys, lifejackets and line-throwing apparatus.

The lectures will be illustrated by lantern slides.

PRESENTATION OF THE ALBERT MEDAL

On Monday, November 4th, the Right Hon. Viscount Bennett, President of the Society, presented to Sir Alexander Fleming, F.R.S., and Sir Howard Florey, F.R.S., the Society's gold Albert Medal, which had been awarded to them " for outstanding services to humanity by the discovery of Penicillin" and "for outstanding services in the scientific application and development of Penicillin" respectively. Members of the Council present were: Lord Aberconway, Mr. F. H. Andrews, Sir Frank Brown, Mr. A. C. Bossom, Major W. H. Cadman, Sir Atul Chatterjee, Sir Edward Crowe, Professor E. C. Dodds, Sir Edward Gait, Mr. E. W. Goodale, Sir Thomas Holland, Sir Harry Lindsay, Mr. G. K. Menzies, Mr. John A. Milne, Mr. E. M. Rich, Mr. A. R. N. Roberts, Mr. E. Munro Runtz, Capt. A. H. Ryley, Sir Frank Smith, Mr. William Will, Mr. J. G. Wilson and Miss Anna Zinkeisen, with Mr. K. W. Luckhurst (Secretary), Miss J. Scott Rogers (Deputy Secretary), and Mr. C. Burns (Assistant Secretary).

Lady Fleming, Lord Moran (President of the Royal College of Physicians), Sir Alfred Webb-Johnson, Bt. (President of the Royal College of Surgeons) and Dr. M. Y. Young, were also present.

The President, in making the presentation, said: We have come here to-day to

honour two very distinguished gentlemen. The contest between man and pain, suffering and disease, has gone on through the centuries. Man has been beaten back time after time; but every now and then we have a sudden flash of the higher intelligences, and as a result we find that we have beaten back the enemy—sometimes not for great distances, but still we have made some progress. In my native country, Canada, an unknown country doctor is responsible for insulin, which has saved the lives of countless thousands. I will not undertake to mention the many advances which have been made, because I shall find myself in difficulties with either the President of the Royal College of Physicians or the President of the Royal College of Surgeons, who have honoured us by their presence.



Presentation of the Albert Medal for 1946 *by the Rt. Hon. Viscount Bennett to Sir Alexander Fleming,* F.R.S. (*left*), *and Sir Howard Florey,* F.R.S.

To-day we are paying our tribute—the highest tribute in the power of the Royal Society of Arts to confer—to two gentlemen, the first being Sir Alexander Fleming. This Society has a medal, known as the Albert Medal and named after the illustrious Consort of Queen Victoria, whose greatness we are just beginning to understand and appreciate. What he did for this country you will find in the records of this Society more clearly set out than anywhere else; and when he passed from this life it was thought by those then governing the Society that we should by some signal act show our respect for that great President and leader. Thus was established the Albert Medal, which has been awarded to distinguished men through the years. We have awarded that medal for conspicuous work, sometimes a great scientific discovery, sometimes the achievements of a statesman, such as Mr. Churchill,

Field-Marshal Smuts or President Roosevelt. But to-day we are privileged to confer that medal upon the discoverer of penicillin. I had the good fortune to cross the Atlantic in the company of Sir Alexander Fleming, and I learned something of the circumstances under which penicillin was discovered. He would say that it had something to do with chance; but it is twenty-odd years of exacting work by a pathologist which has resulted in this discovery. It was not an accident in that sense, and he at once gave a name to his find because he realised to what family it belonged. The service thus rendered to humanity by that discovery is the reason for our presenting him to-day with the Albert Medal, and among the long lines of illustrious men who have received that medal I think you will find that in service to humanity there has been no one who is more deserving of it.

Sir Alexander, I now present you with this medal on behalf of the Society, with the strong conviction that we could not present it to any one more worthy who has made a major contribution to the well-being of mankind.

There is but one award. We realised that the service to humanity which was rendered by Sir Alexander Fleming might not have become the great agent that it has in the relief of pain and suffering and in its curative qualities unless it could be adapted for practical use. As in the case of insulin and Dr. Banting, where Dr. Best, as a biochemist, rendered service that made insulin so valuable, so Sir Howard Florey was able to make this a living, vital factor in service to humanity. It is always difficult where you have a situation such as that to say that one shall have and the other shall not, and so in its wisdom the Council of the Society determined that the proper course to pursue was to make a joint award—not to cut the medal in two, but to present a medal to each of them. Ideas come to the minds of many people. Someone may be able to crystallise an idea and make it active and useful, and still the idea originated with another. In this case, the discovery of penicillin was made by Sir Alexander Fleming, but it was for a service rendered in a practical way, and, as stated on the medal, "for the scientific application and the development of penicillin" that we honour Sir Howard Florey to-day, realising that by his efforts penicillin has been made beneficial to mankind.

Sir Howard, I have great pleasure in presenting you with the Albert Medal of the Society.

Sir ALEXANDER FLEMING replied: I thank you for your kind and flattering words and I am very grateful to the Society for awarding me this medal. You have said it is the highest honour which it is in your power to bestow and I can assure you that I am deeply conscious of the honour you have done me in considering me worthy to have my name appear with the great names which figure in the list of Albert Medallists.

I am here because of penicillin and I am only here because in regard to penicillin fortune was kind to me. A mould spore lit on a culture plate of bacteria where it was not wanted. There are thousands of different moulds and thousands of different bacteria and if the right mould had not contaminated the right bacterial culture at the right time there would not have been anything extraordinary to notice. Then my mind might not have been in a receptive mood at the time. I might have been in a bad temper or something might have happened to make me full of joy,

and in such an emotional state it is unlikely that I would have noticed anything; or I might have had a heavy meal, when my cerebration would have been too slow to notice anything!

But I was fortunate, everything happened just right. I often wonder whether we would yet have had penicillin if I had not described it in 1929. We should not have had it for ten years, as nobody was then interested in antibiotics. Perhaps we should not have had it even now. But if someone else had described it, would it have been called penicillin? Perhaps, perhaps not. But penicillin is a good name—it slips easily off the tongue—and penicillin is a very good substance. No doubt I have missed chances. I know I have. But fortunately I have not missed them all; and still more fortunately I did not miss the chance which has led, through the work of Sir Howard Florey and others, to penicillin as we know it to-day.

I am very proud to receive the Albert Medal, and I thank you.

Sir HOWARD FLOREY also acknowledged the presentation and thanked the Society for the honour it had paid him.

MEETING OF COUNCIL

A meeting of the Council was held on Monday, November 11th, 1946. Present: Viscount Bennett (in the Chair); Lord Aberconway; Lord Amulree; Mr. F. H. Andrews; Sir Frank Brown; Major W. H. Cadman; Sir Atul Chatterjee; Sir Edward Crowe; Sir Edward Gait; Mr. E. W. Goodale; Dr. R. W. Holland; Sir Thomas Holland; Mr. Basil Ionides; Sir Harry Lindsay; Mr. G. K. Menzies; Mr. J. A. Milne; Mr. Keith Murray; Mr. J. W. Ramsbottom; Mr. E. M. Rich; Mr. A. R. N. Roberts; Mr. E. Munro Runtz; Captain A. H. Ryley; Viscount Samuel, and Mr. William Will; with Mr. K. W. Luckhurst (Secretary) and Mr. C. Burns (Assistant Secretary).

The following were duly elected Fellows of the Society:

Addy, Roland, Barnsley.
Allen, Professor Jack, D.Sc., Aberdeen.
Barry, William Cyril, B.Sc., Kent.
Barton, Leonard, A.R.C.A., Lancaster.
Black, Thomas Charteris, Herts.
Bruches, Rev. Reuben Solomon, Lancashire.
Carter, Albert, J.P., Birmingham.
Cayzer, Sir William Nicholas, Bt., Chester.
Coop, Eric Warner, London.
Corry, Sir James Perowne Ivo Myles, Bt., London.
Dalrymple, Ian Murray, B.A., Gloucester.
Daly, Ivan de Burgh, F.R.S., M.A., M.D., Edinburgh.
Daniels, Ernest George, Birmingham.
Darbishire, Miss Helen, Oxford.
Denby, Miss Elizabeth Marian, London.
Dimsdale, Wilfrid Hampden, M.A., London.
Edgard, David Harry, Cumberland.
Exley, Allen, Lancashire.
Farmer, Capt. George James St. Francis, Warwickshire.
Fergyson, John William, Nottingham.
Foster, Charles Edwin, Hertfordshire.
Fuller, Stanley Redvers, Surrey.

Gamage, Leslie Carr, M.A., M.C., London.
Haley, Sir William John, K.C.M.G., London.
Hedges, Ernest Sydney, D.Sc., PH.D., Middlesex.
Hirst, Professor Edmund Langley, M.A., D.Sc., F.R.S., Manchester.
Hoban, Francis Joseph, Chester.
Johnson, Arthur, Leeds.
Kirke, Harold Lister, London.
Lutyens, William Frederick, Sussex.
McAvity, Mrs. E. Dorothy, Canada.
Malik, G. N., India.
Mallett, George Leonard, Birmingham.
Mayer, William Edgar, Lancashire.
Miller, Professor William Christopher, Suffolk.
Morley, Eric, Bradford.
Page, Thomas George, London.
Parish, George Harold, Nottingham.
Rainer, Claud, Kent.
Shakeshaft, Frederick, London.
Sinkinson, Gordon, Lancashire.
Smith, Major Raymond Stanley, London.
Taylor, Maurice Campbell, Cumberland.
Towns, William Henry, London.
Walker, Edwin, Derbyshire.
Watson, John, Lancashire.

The Council agreed to the holding of Royal Society of Arts Examinations in the English Language in Holland.

Possible action by the Society in connection with the proposals for a 1951 International Exhibition was discussed.

It was reported that the entries for the November Examinations totalled 5,681.

A quantity of formal and financial business was transacted.

THOMAS GRAY MEMORIAL TRUST

Award of Prizes to Merchant Navy Apprentices and Cadets

The Council, acting under the Thomas Gray Memorial Trust, have approved the award of fifteen prizes in connection with the 1945 Examinations of the Merchant Navy Officers' Training Board, five to the entrants displaying the greatest proficiency in each of the three years of apprenticeship. The first prize in each year was a sextant, the second a pair of prismatic binoculars, and the other prizes were telescopes and binoculars. The awards were made to the following cadets and apprentices:

Seniority Third Year

N. R. Knowles (Union Cable Mail Steamship Co.) (First Prize).
D. Hargreaves (British India Steam Navigation Co., Ltd.) (Second Prize).
J. S. Andrews (C. T. Bowring & Co., Ltd.).
R. K. Learoyd (H. E. Moss & Co.).
D. M. Robinson (Port Line, Ltd.).

Seniority Second Year

R. S. Webster (The New Zealand Shipping Co., Ltd.) (First Prize).
C. P. Hicks (Peninsular & Oriental Steam Navigation Co.) (Second Prize).
J. Brierley (Port Line).
S. M. Hatcher (Prince Line).
J. G. Street (Royal Mail Lines, Ltd.).

Seniority First Year

R. E. Hall (Elder Dempster Lines, Ltd.) (First Prize).
N. A. Hill (Prince Line, Ltd.) (Second Prize).
J. V. Beswick (Headlam and Son).
R. H. Biggs (Prince Line, Ltd.).
M. J. Ruffhead (The Anglo-Saxon Petroleum Co., Ltd.).

OPENING OF THE 193rd SESSION

WEDNESDAY, NOVEMBER 6TH, 1946

The Right Hon. VISCOUNT BENNETT, K.C., P.C., LL.D., *President of the Society, in the Chair*

The 193rd Session was opened on November 6th, at 5 p.m., by Viscount Bennett, President of the Society and Chairman of the Council. He prefaced his address by saying that he had contemplated a more ambitious paper, but he had been somewhat incapacitated and his eyes had failed him. He therefore had had to depend upon the Secretary and Miss Scott Rogers. The President then went on :

Among the many qualities of our ancient Society, one which is outstanding is its essentially English character. In fact, it is so English as almost to be Irish! Consider the following anomalies. The full and correct title of the Society, although it was adopted at its inception and is still valid, is generally quite unknown. The Society's premises in the Adelphi were built for it in 1774, twenty years after its establishment, but they did not become the Society's property until 150 years later. The Society has enjoyed the support of a succession of Royal presidents for over a century, but it only acquired for itself the title "Royal" some thirty years ago. There are two other facts, to which I wish more especially to draw attention this evening. The first, that the Society had no governing body until it was all but a hundred years old; the second, that it was only a century ago, when the Society was already nearly a century old, and had left its mark on every aspect of our national life, that legally it attained corporate existence. For it was in June, 1847, during the 93rd Session, that the Society received its Royal Charter.

I propose to make this latter important event an excuse for turning our thoughts at this Opening Meeting of the 193rd Session back for 100 years in order, very briefly, to attempt two things. First, to recapitulate the circumstances of the reorganisation of the Society, of which the grant of the Charter was the climax; and secondly, to consider some remarks of the then President, Prince Albert, which were quoted by the Chairman of Council at the Inaugural Meeting of the 93rd Session.

As I have just said, the grant of the Charter was the culminating point in a period of profound changes within the Society by which, in its typically English manner, the Society reorganised itself and its methods to meet the equally profound changes which had taken place outside. In the early forties of the last century the Society seemed to have outlived its usefulness. The chief method which it had successfully employed to achieve its ends in the eighteenth century, namely, the stimulation of

industry by the offer of prizes, was quite outdated by the mid-nineteenth century, and much of the wide field originally covered by the Society of Arts had, in the meantime, been taken over by newer and specialist bodies.

I have been reading recently with great interest the Address which was presented by the Council to the Society at the beginning of the 93rd Session. This Address contains a passage dealing very pointedly with this second circumstance, the development of new Societies. "At the commencement of last Session", it says, "the Council made it their business to re-examine very closely the position which, with relation to other Societies, the Society of Arts ought now to assume. Formerly, as is well-known, it stood alone as the great Active, Scientific, Mechanical and Artistic Society of London; the Royal Society being the only other in any analagous position to it. Now, however, that great field is happily full of co-operative societies, each labouring on some one subject formerly a mere department of one vast territory. This removal from the parent society of so many branches has necessarily stripped the Society of Arts of many of its bright ornaments. But it appears to your Council, that far from being regarded as an evil, this multiplication of useful societies is a subject for congratulation. It should be regarded as one of the strong proofs of the past usefulness of the Society, that it has given birth to so many useful institutions, that it encouraged the taste for art and science, and invention and manufactures, when no one else would or could, and that it was not until they were able to provide for themselves a larger sphere of usefulness that they were removed from us and planted in a fresh and fruitful soil. In science, in art, and invention, division of labour is one of the direct consequences of progress as well as its most powerful instrument".

While, however, the newer societies thus referred to busied themselves in their respective spheres with all the enthusiasm and efficiency of youth, their parent, the Society of Arts, was, at the time I have just mentioned, falling into a condition of dotage. Its meetings had by this time come to be largely occupied with interminable discussions on procedure which remind one not a little of some recent international conferences, and little solid achievement resulted from them. In consequence, the members, and especially the more influential supporters, were dropping off, and financially the Society was on the brink of bankruptcy. At the end of 1841, only £400 remained in the accumulated funds to meet the future deficiencies which, unless something radical were done, were sure to accrue.

A special Committee, therefore, presided over by Thomas Webster, the father of Lord Alverstone, was appointed to look into the situation, and it is to this Committee in general and its Chairman in particular that the Society owes its rebirth, and in fact its existence to-day. The two main recommendations of this Committee were firstly, the creation of a governing body, and secondly, that the Wednesday evening meetings should be used for the reading and discussion of papers. Until this time the Society had been run on extreme democratic lines. All its business was transacted at open meetings, town's meetings, as it were, attended by all and sundry of its members, and although there were indeed a number of specialist committees, all the members of the Society were equally members of all the Committees. The weekly meetings were, therefore, in the nature of business meetings at which the offering and award of premiums and the resulting correspondence were discussed.

It was now recommended that the administrative affairs of the Society would be more efficiently conducted by a small body with this definite responsibility, thus freeing the Wednesday evening meetings for the much more profitable purpose of the dissemination of knowledge. The proposals met with bitter opposition, and it was only after the support of the President, the Duke of Sussex, had been obtained that they were finally adopted in April, 1843. The consequent reorganisation of the Society took a considerable time, and it was not until December, 1845 that the new rules and regulations were completed, and the Council met for the first time that month.

The establishment of our Council and the grant of our Charter are very closely linked, for the Council was barely two months old when, in February, 1846, it decided that steps should be taken to make applications for a Royal Charter. In December of that year a draft of the Charter was considered, and in March, 1847, a draft, together with a petition, were approved by the Prince Consort (who was by then President of the Society) and lodged in the Privy Council Office. By June, 1847, the Charter had been granted, and with this event, to quote Sir Henry Trueman Wood, the historian of the Society, who was its Secretary for forty years, "the first period of the Society's history may be held to have come to an end. After this it may be said to have entered on a new chapter of its existence. It found new aims and adopted novel methods; not only its constitution but its character was to a large extent altered, and with a reorganised system it may certainly be said to have started on a fresh career of usefulness".

Of the novel methods to which Trueman Wood refers I have only time to mention two; one of these, namely, the devoting of the Wednesday evening meetings to the reading and discussion of papers, I have already referred to. This recommendation of the Webster Committee took effect sooner than the establishment of the Council, and by 1845 the experiment had so far succeeded that it was decided to establish an honorary testimonial to be presented "to persons making communications which might appear to the Society deserving of such notice". The distinguished gentlemen who are this evening to receive tangible recognition for the papers which they contributed to the Society's proceedings during the past Session may be interested to learn how ancient this custom is. Five years after the institution of the honorary testimonial, a silver medal, indicative of the increasing importance attached to the communications for which it was awarded, was substituted for the paper certificate. Perhaps before long we shall have to change the material of our award again and present our worthy lecturers with a disc of cupro-nickel! Although the institution of the custom of reading papers at our weekly meetings slightly preceded the setting up of the Council, I think we may safely say that it was the Council who converted the experiment into a permanent and successful custom. For the selection of papers and compilation of a programme is a matter which requires the consistent and deliberate organisation which only a proper system of government can provide. During the 100 years of such meetings now completed what a wealth of important information has been first imparted or further disseminated from our lecturer's dais! It would be invidious for me (even if I had the time) to select any outstanding papers. Suffice it to say that after 100 years we still regard this as the most important and useful function of the

Society, and that we believe with full confidence that the standard of the papers read here is as high as it ever was. I can assure you that the Medals Committee, which has strict instructions from the Council to limit the number of awards for papers, finds the greatest difficulty each year in keeping within the prescribed bounds.

A natural corollary to the institution of the reading and discussion of papers was their publication for the benefit of a wider public. It is remarkable how little importance was attached during the first half of the Society's history to the dissemination of information by means of the printed page. Only a very few of the valuable communications made to the Society in its early years ever went into print; and these in a purely casual way, either as articles in the *Gentleman's Magazine* and other periodicals, or in the three volumes of *Memoirs of Agriculture and other Economical Arts* which one of the members, Robert Dossie, obtained permission to publish as a purely personal enterprise, but which were entirely devoted to Society of Arts matter. It was not until 1783 that the Society commenced to publish official transactions, but thereafter a volume was published annually until 1830, and after that in alternate years until 1844; when the series, the quality of which had varied greatly and had latterly perceptibly deteriorated, was discontinued. An attempt was made to revive the practice with a handsome volume containing the text of the Charter and the Proceedings for 1846 to 1848, and again with the Proceedings for the Session 1850–51. Then in 1852 began the publication of the weekly *Journal*, which, except for the present temporary substitution of fortnightly for weekly publication, has continued without intermission ever since. In a fortnight's time we shall be opening the 95th volume with the 5,731st number of our periodical. If it were possible to trace all the practical effects of this journalistic effort, how fascinating the story would be! As a periodical published at regular intervals and containing up-to-date information on a wide variety of subjects, the educational value of the *Journal* is obvious. But the *Journal* is much more than that. Many of its papers have stood for years as the authority on their subject, and many of them indeed formed the first announcement of discoveries of great importance. The value of others, and this, I think, applies to many papers and lectures of the present day, is that they bring together, in the hands of an expert, a range of up-to-date information which is otherwise widely scattered among the more technical papers of limited scope published by the specialist bodies. In such papers particularly the Society performs one of its chief functions to-day as a liaison between more specialised bodies, and this function, which is based on our history and tradition, gives the *Journal* its unique character. I can assure you that overseas, where copies of the *Journal* are not so easily come by as in this country, each issue is eagerly sought after, and most copies pass through many hands each fortnight. During the war years we have been compelled by shortage of paper not only to reduce the frequency of our publication, but also to crowd our pages with small print. I am glad to be able to say that the recent easing of the paper situation will make it possible for our type and lay-out to resume something of their old readability with the first issue of the new volume.

Of other results of the reorganisation of the Society 100 years ago there may perhaps be some other opportunity to speak. It must suffice to sum up what the

story shows, viz., that the very antiquity and rich tradition of this Society, upon which we so justly pride ourselves, are actually a danger, unless we are prepared to accept the changes which have taken place outside and adapt ourselves to them. If, however, we are prepared to be realistic, this Society, because of its breadth of basis, as well as its deep roots, always has within it the possibility of finding in fresh circumstances a new sphere of usefulness. This point is also brought out in the address of Council in 1846, to which I have already referred. After the passage quoted, the address goes on to say: "But there is one department of the Fine Arts very peculiarly belonging to this Society, which its very title clearly indicates. It was the remark of our Royal President, the Prince Albert, made to a deputation from your Council, when waiting upon him on the business of this Society, that the department most likely to prove *immediately* beneficial to the public, would be that which encourages most efficiently the application of the Fine Arts to our Manufactures. It is the application of the arts of design to the mechanical manufactures of this country that is alone requisite to enable her to stand without a rival. . . . Of high art in this country there is abundance, of mechanical industry and invention an unparalleled profusion; the thing still remaining to be done is to effect the combination of the two, to wed high art with mechanical skill. The union of the artist with the workman, the improvement of the general taste of our artificers and of the workmen in general—this is a task worthy of the Society of Arts, and directly in the path of its duty. Such were the sentiments expressed by the Prince, our President; such also are the views which have guided your Council in their proceedings during last year. They have reason to think that this is one of the most promising and valuable spheres of future usefulness to the Society".

The report goes on to state: "The Council believe that the higher the artistic talent called into requisition by the manufacturer, the more successful is it likely to become; they believe also that one great means for the promotion of art and the cultivation of taste is to surround us as much as possible with common objects of beautiful forms, so as to educate the people by the habit of looking on good designs and elegant proportions". How far-sighted these men were and how much ahead, not only of their own times, but alas, of ours too! For the marriage of high art and mechanical skill, although perhaps the nuptials have been celebrated, is as yet far from being consummated. Has the Society of Arts, then, failed in its duty, the path of which lay, in the view of the Prince Consort, in just this sphere? The present is surely an appropriate moment to take stock and offer some brief answer to these questions.

Before coming to the century just completed, it might be well to remind ourselves that the Society paid attention to what was later termed "Industrial Art" in its earliest years. In 1754 it offered prizes for "the most ingenious and best fancied designs . . . proper for Weavers, embroiderers or calico printers", and in 1778 it was claimed that "the elegance of pattern adopted by weavers and calico printers may with justice be attributed in a great degree to the rewards and attention bestowed on them by the Society". Unfortunately, however, although occasional awards were offered for various forms of industrial art, there was no consistent policy in this direction until the time which we now commemorate, when the influence of the Prince Consort, added to the far-sightedness and enthusiasm of

some lesser-known members of the Society, brought this activity into a foremost place in our affairs. From this time, however, things began to move rapidly: at the very first meeting of the Council, in December 1845, a sum of fifty guineas was offered, through the Secretary, and it is believed actually by the Secretary, for prizes for improved designs of "useful objects calculated to improve general taste". A fund for this purpose was subscribed and a first offer of prizes was made in the year 1846. The response was meagre, but the offer of prizes was renewed in 1847, and the prize articles, together with articles specially lent by manufacturers, were shown at the Society of Arts' first exhibition of "Select specimens of British Manufactures and Decorative Art" which was opened at the Society's House in March, 1847. Here we have brought together the two chief methods which the Society has adopted throughout the past hundred years for the furtherance of industrial design, namely, the award of prizes in competition and the exhibition of selected designs.

There is no time this evening to trace the fascinating story of how the movement I have just described led in due course to the Great Exhibition of 1851. There will doubtless be other occasions when the part played by this Society in that great venture can be detailed. It must suffice at present to remind you that the Great Exhibition originated directly from this Society with the encouragement and advice of its President, Prince Albert, and that not only did the Society of Arts contribute the idea, but its members, by their energetic canvassing of manufacturers and their raising of a guarantee fund of £100,000, assured the success of the Exhibition long before the first foundation was laid in Hyde Park.

As a result of the part played by the Society of Arts in originating the 1851 Exhibition, the Society was given full responsibility for its successor, the 1861 Exhibition; and it had an influential if not controlling share in the arrangements for numerous other important exhibitions during the latter part of last century. Wherever possible the Society saw to it that these exhibitions served the purpose of furthering design which had been so much in the mind of the Prince Consort in connection with the 1851 Exhibition.

There were, also, during that half-century a number of offers of prizes, the most notable of which was the series of prizes for art workmanship offered annually from 1863 to 1870, where, however, the emphasis was more upon the workmanship than the design. In 1878 the Society also began to offer, under the Owen Jones Trust, a series of annual prizes to students of art schools for various types of design.

At this point I must mention one action of the Society which is very little known, namely, the establishment of the School of Woodcarving. The Society has, in the course of its history, been directly responsible for the establishment of two educational institutions, the more important of the two being the National Training School for Music, which became the Royal College of Music of to-day. The School of Woodcarving originated in 1878 through an offer by the Drapers' Company of a sum of money to be applied to the promotion of some branch of technical education. The Council decided to devote the money to the encouragement of wood carving, an art which had long prospered in this country but was then languishing. Nine free students were nominated and a few paying students were admitted, the instruction at first being in the hands of a Florentine woodcarver

named Antonio Bulletti. The school changed its home several times and was for a considerable period fostered by the City Guilds Institute. Early this century it received the support of the London County Council.

In 1886 the Society decided to show the flag of design in a different way, by instituting an Applied Arts Committee, with the responsibility of organising from four to six lectures each session on the applications of art to industry. This section continued its work for over twenty years and the papers which were published under its auspices not only helped to maintain an interest in Industrial Art throughout this period, but collectively formed an interesting and valuable *corpus* of information on the subject. Many notable people, including William Morris, were among the contributors to the series.

I come now to more recent times and the period between the two Great Wars. In 1922, at the instigation of the late Sir Frank Warner, the Council decided to initiate a new series of annual competitions of industrial designs, and as a result of the support given by many firms of manufacturers and by individuals, competitions were held for ten years, from 1924 to 1933, for which there was a total entry of over 10,000 competitors and a total award of over £11,000 in prizes and travelling scholarships. After the awards had been made, exhibitions of selected designs were held each year. There is no question that these competitions and exhibitions achieved a great deal in the improvement of the standard of work by art students and in increasing the interest of manufacturers in design. Many of those whose names appear in the prize lists have since become well-known, and in some cases their success in winning a prize was the means of opening the door to a subsequently successful career. The burden of the administrative expenses of the competition, however, which amounted in ten years to about £5,000, was more than the Society could continue to sustain, and after the 1933 competition there was a gap of a few years until in 1937 the competition was revived on fresh lines. Instead of a multiplicity of awards, it was then decided to pool the prize money and institute a co-ordinated scholarship scheme, making the educational objective of the competition the primary one. The competition on these revised lines has been continued annually ever since, except for three of the recent war years, and so far twenty-one awards, with a total value of £2,100, have been made. Naturally the war interrupted the careers of some of the students whom the Society was seeking to help in this way, but it is encouraging that although the competition is a comparatively recent effort, a number of the successful students already hold important positions as designers, and the work of several of them may be seen at the present moment at the "Britain Can Make It" Exhibition.

Two other very important actions by the Society in this field remain to be referred to. These are the Exhibition of British Art in Industry, held in collaboration with the Royal Academy at Burlington House in 1935, and the establishment of the distinction of R.D.I. in 1936, both of which were largely due to the influence of Mr. J. A. Milne. The Burlington House exhibition was an entirely new type of industrial exhibition, as no charge was made for the space allotted to manufacturers; in consequence, the organisers of the exhibition had full control over the selection of the exhibits and only those articles were shown which it was felt would further the purposes of the exhibition. These purposes were, briefly, to establish the

position of designers by associating their names with the products which they had designed, and to demonstrate that good design could be applied as well to mass-produced articles as to those more expensively made. There is no doubt that it attained to a large extent the first of these objects; as to the second, the difficulty which was encountered in finding enough well-designed mass-produced objects to display was itself an object-lesson, and there is no doubt that much advance has been made in this matter since that time. It is also of interest and importance to note that the principle of unfettered selection in an exhibition of manufactured articles which was introduced by the Burlington House exhibition has recently been adopted as the foundation of the Government-sponsored "Britain Can Make It" Exhibition.

After the Burlington House exhibition the Council, in furtherance of its policy of enhancing the status of the designer, decided to institute a distinction for leading designers, to be known as "Designer for Industry of the Royal Society of Arts" and indicated by the letters "D.I." and subsequently "R.D.I." after their names. In the few years since the establishment of the distinction, the R.D.I. has come to be well recognised as the highest honour to which an individual designer, *qua* designer, can attain. Moreover, its recipients have been brought together by the Council of the Society as a Faculty, and we hope that before long they will collectively be able to exercise a formative influence of the greatest importance on design.

During the recent war the Society made another valuable move in the field of industrial art by establishing the War Memorials Advisory Council, which came into existence as the result of a Conference organised by the Society. This Conference stressed the need for a high standard of artistic merit in the memorials to be erected. The Council, as its name implies, acts in an advisory capacity and its work of guiding local committees in the choice of appropriate memorials still continues.

The sketch I have attempted to draw of a century's labours in one particular field has necessarily been hasty and superficial. However, beneath all the activities which have appeared on the surface the most important thing to remember is that throughout this long period the Society maintained a concern for this important subject, and that the recent evidence of a quickened consciousness among the nation as a whole is the fruits of our century of sowing.

At the outset of my remarks, I reminded you that the Council 100 years ago viewed with pleasure, not unmixed with pride, the growth of numerous co-operating societies which filled the wide field once solely occupied by the Society of Arts. Now, owing in no inconsiderable degree to the persistent efforts made by this Society, the field of industrial art, which the Society made particularly its own 100 years ago, has likewise witnessed in recent years the development of specialist societies within it, and to these we wish all success in the particular paths which they have marked out for themselves. At the same time it is our intention to continue to make our own contribution to the development of this subject, and I wish now to announce a new endeavour of the Society, which I am sure you will agree it can most appropriately undertake. It was, as you will remember, within the councils of this Society, under the leadership of its President, that the plan for the 1851 Exhibition was conceived, and in fact worked out in some detail. There has been considerable

talk recently of the holding of an International Exhibition in 1951, the centenary year of the 1851 Exhibition. No exhibition can be a success merely because it celebrates the centenary of a previously successful exhibition, and it is essential that a 1951 Exhibition should be based upon a plan and policy suited to its own times. Feeling this, the Council of the Royal Society of Arts have decided to offer a prize; the details of this will be announced in due course, but the main purport of the offer is as follows. The prize will be the sum of 500 guineas, and it will be awarded for the best paper submitted in competition, setting out the purposes—national, imperial and international—which might be served by such an exhibition, and offering in broad outline practical proposals for effecting these purposes.

The PRESIDENT then presented the Silver Medals awarded for papers delivered during the past session. He explained that the Council had provided that those who received these awards could choose whether to have books or medals, but would in any case be known as "Silver Medallists." He then presented medals or books to the following:

Major W. H. Cadman, for his paper on "Colloidal Carbon".

Sir Charles Goodeve, F.R.S., for his paper on "The Defeat of the Magnetic Mine".

Major Frank Halford, for his paper on "Jet Propulsion".

Kenneth Holmes, for his paper on "The Place of the Art School in the Life of the Community".

A. C. Hartley, C.B.E., for his paper on "Operation Pluto".

Dr. A. S. C. Lawrence, for his paper on "The Future of Scientific Films".

Dr. A. S. Parkes, F.R.S., for his paper on "Hormones".

Charles Seltman, M.A., for his paper on "The Appreciation of Greek Art".

Sir Horace Wilson, G.C.B., for the Amulree Memorial Lecture, "William Warrender Mackenzie, Baron Amulree of Strathbraan: his Influence on Industrial Relations".

Sir Alexander Campbell, for his paper, "Education in Burma".

Percy Evans, for his paper on "The Oilfields of India and Burma".

Sir Edward Salisbury, F.R.S., for his paper, "The Work of Kew in the Interests of the Overseas Empire".

Owing to absence abroad, the following lecturers were unable to attend to receive their awards:

Mr. G. Macdonald, for his paper, "Tropical Hygiene and the Overseas Empire."

Dr. E. P. Weeks, for the Neil Matheson McWharrie Lecture, "Canada and Post-war Reconstruction".

An engrossed Certificate was then presented under the Thomas Gray Memorial Trust, to Mr. W. J. O'Brien, for his invention, the Decca Navigator, a radio system which enables the position of an observer to be established to a high degree of accuracy.

Sir EDWARD CROWE, K.C.M.G. said: It is my privilege to-night to propose a hearty vote of thanks to our President for his Inaugural Address and for all the work that he has done for this Society during the past year and for what he is going to do in years to come. As Lord Bennett told us, this particular Inaugural Lecture was not completely prepared by him, so therefore a certain amount of credit must go to the Secretary and Miss Scott Rogers, but I think you will all agree that it is entirely owing to the personality of our President that this paper has really gone home.

It is fortunate that the President selected for to-day's address the subject of exhibitions, with particular reference to the great exhibition which we hope to see held in 1951. I trust that all of you have examined the exhibits in this room and have studied the Society's Minutes, beautifully written as you might expect, and corrected in very fine handwriting, by the Prince Consort himself. He was a great man, who inspired those who worked with him, and he did an enormous amount for the Exhibition of 1851.

I have sat on many committees when the great need for the improvement of design in art and industry was discussed. But if you look at these old minute books you will find that 100 years ago this subject was very much in the minds of people. The Prince Consort himself devoted special attention to it. We have made considerable progress; but under the inspiration of those who will run the 1951 Exhibition I hope that we shall make still greater advances. We must all hope that the hundreds of thousands of people who will come from all parts of the world to visit the exhibition will go back to their countries satisfied with what they have seen—that they will buy more and more British goods and will thus enable Britain to return to really prosperous days. I hope that it will be possible in 1951 for people to buy goods without having to stand in queues, that visitors who come to this country will get accommodation in first-class hotels. Remember that however superlative the goods in an exhibition may be, what sticks in a visitor's memory is the comfort of the hotel in which he stays. I hope that the Government will treat this 1951 Exhibition as a matter of first priority, so that hotels will be ready for our visitors. If I were going to compete for the prize which Lord Bennett has announced to-night, one of the things on which I would lay the greatest stress is the fact that we must be ready on the opening day.

I will now ask Mr. Milne to second this vote of thanks.

Mr. J. A. MILNE: I should like to endorse everything that has been said about our Lord President, who is a tower of strength to the Society. We can never be grateful enough to him for the time he has given and for the magnificent work which he has done, and which we hope he will go on doing for a very long time to come.

The vote of thanks to the President was carried with acclamation.

The PRESIDENT: I see on the face of at least one gentleman a look of apprehension that I may be tempted to make a speech. I have no intention of trespassing on your time except to say how glad I am that you have come here this afternoon; and I trust that the younger people will see in this Society an opportunity to render some service to the generations to come. When you think of the services rendered to this generation by the men of whom I have been speaking and what they did in 1851 and thereabouts you cannot but realise that this generation has an even greater opportunity. One would like to think that, inspired by the magnificent achievements of the past and cheered by the strength of the present which is, I trust, being augmented every day, we may accept the challenge, for it *is* a challenge, to this generation. Let us accept it with determination, great determination, and willingness to work—which is more important still. We must make some contribution to our day and generation which will be worthy of our ancestry.

The proceedings then terminated.

GENERAL NOTES

THE ROADS BEAUTIFYING ASSOCIATION.—The need for advice to planners of housing estates and highway developments on schemes of tree and shrub planting, is rapidly increasing. The Roads Beautifying Association has made this its work. Full planting schemes, estimates of cost, planting instructions, and examination of stock from nurseries, have been carried out for building estates in many parts of England.

The planting of roads involves the consideration of highway verges and anti-dazzle screens. In the case of the latter the requirements of beauty can be made to serve the interests of safety. A screen of trees or shrubs in the centre of a double carriage-way road can effectively shut off the lights of one line of traffic from the view of those driving in the opposite direction. The shrubs should be evergreen or densely twigged, and must be thicker on bends where the headlights strike the screen less obliquely. In this case, utility and safety should ensure the popularity of one of the amenities which the Roads Beautifying Association exists to further.

THE UNESCO PROGRAMME.—The United Nations Educational, Scientific and Cultural Organisation Conference which opened at the Sorbonne, Paris, on November 19th, is to consider the programme of work to be done by UNESCO.

Its main work, under many subdivisions, will be to co-ordinate education and research in different countries, and to undertake educational projects, of an international character, for which no suitable organisation had hitherto existed.

Amongst the projects to be considered are the relief and rehabilitation of education in countries devastated by war; the initiation of surveys of school text-books, of the place of the arts in education, and of the obstacles to the flow of information across international boundaries; the preparation of international conventions on educational and scientific films; the establishment of a translation bureau, and the study of anti-illiteracy campaigns and mass education.

About 2,000 delegates, advisory experts, and observers from most of the United Nations will be attending the conference, which will continue until December 10th.

EXHIBITION, "A MODERN SWEDISH HOME".—An exhibition, entitled "A Modern Swedish Home", was opened at the Building Centre by Lord Sempill on November 8th. The exhibition is held under the auspices of the Building Centre with the support of the Design and Industries Association and the Council of Industrial Design. It displays modern Swedish furniture and textiles, including examples of the "knock-down" or package furniture built for rapid assembly and dismantling for transport.

The exhibition is open from 10 a.m. to 6 p.m. on weekdays till November 30th, inclusive.

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To save paper, distinctions after the name are given in the first instance only.

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Architects' Registration Council Board of Architectural Education—Basil Ionides, F.R.I.B.A.

C.P.R.E. (Council)—J. A. Milne and G. K. Menzies.

C.P.R.E. Panels Committee—G. K. Menzies.

Chadwick Trust (Trustees)—E. M. Rich.

London Society (Council)—Lord Broughshane.

Soane Museum (Trustees)—Prof. A. E. Richardson, R.A., F.R.I.B.A.

British Film Institute (Committee)—C. G. Holme.

National Film Library of the British Film Institute (Management Committee)—Sir Harry Lindsay.

Charing Cross Hospital (Life Governor)—Brigadier Sir Edward A. Tandy.

Institute of Physics—Sir Clifford Paterson.

Standards Committee of the Directorate of Post-war Building—F. H. Andrews.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, NOVEMBER 25..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. J. A. Sumner, "**The Heat Pump.**"

Geographical Society, Royal, Exhibition Road, S.W.7. 8 p.m. Professor Hans Pettersson, "**Deep Sea Explorations in the Mediterranean.**"

Industrial Transport Association, at the Stork Hotel, Queens Square, **Liverpool, 1.** 7 p.m. W. G. Anwyl, "**1896–1946.**"

Physics, Institute of, at the Royal Society, Burlington House, W.1. 5.30 p.m. R. C. Oldfield, M.A., "**Psycho-Galvanic Reflex.**"

TUESDAY, NOVEMBER 26..Anthropological Society, Royal, 21 Bedford Square, W.C.1. 5.30 p.m. Jozef Obrebski, PH.D., "**Changing Peasant Culture in Poland.**"

Chadwick Trust, at the Institution of Structural Engineers, 11 Upper Belgrave Street, S.W.1. 2.30 p.m. Professor H. J. Collins, M.C., M.SC., "**Some Aspects of Structural Engineering.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. D. C. Birkinshaw, M.B.E., M.A., "**The Economics and Subjective Requirements of Television Picture Sizes.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester, 3.** 6.30 p.m. Miss Ida Holbrook, "**A Holiday in Yugoslavia.**"

Television Society, at the Institution of Electrical Engineers, Savoy Place, W.C.2. 6 p.m. C. L. Hirshman, "**Television Picture Quality.**"

University of London, King's College. 5.30 p.m. Maurice B. Reckitt, M.A., "**Maurice to Temple: A Century of the Social Movement in the Church of England.**" (Lecture VI).

At School of Slavonic and East European Studies. 5 p.m. W. K. Matthews, M.A., PH.D., "**The Languages of the U.S.S.R.**" (Lecture II).

At 6 p.m. F. Friedeberg Seeley, M.A., "**Pushkin.**" (Lecture VI).

WEDNESDAY, NOVEMBER 27..Chemical Society, at the University, **Liverpool.** 7 p.m. A. V. Billinghame, B.SC., "**The Development and Industrial Application of Wetting Agents.**"

Folk-Lore Society, at the Royal Anthropological Institute, 24 Bedford Square, W.C.1. 5.30 p.m. Arthur Waley, "**The Chinese Cinderella Story.**"

Foundrymen's Institute of British, at the Waldorf Hotel. 7.30 p.m. E. Raybould, "**The Theory and Practice of the Aluminium Sand Foundry.**"

Kinematograph Society, British, at the Wellcome Foundation, 183 Euston Road, N.W.1. 7.15 p.m. Dr. Denis Ward, "**Problems of 16 mm. Production.**"

United Nations Fellowship, at the Royal Empire Society, Northumberland Avenue, W.C.2. 7.30 p.m. M. M. Semet, "**Two-Way Traffic in Anglo-French Understanding.**"

University of London, School of Slavonic and East European Studies. 6 p.m. Professor R. R. Betts, M.A., "**Central Europe Between 1346 and 1526.**" (Lecture VI).

THURSDAY, NOVEMBER 28..Dyers and Colourists, Society of, at the Great Northern Victoria Hotel, **Bradford.** 7.15 p.m. M. H. Wilkinson, "**The Bleaching of Animal Fibres by Modern Methods.**"

Mechanical Engineers, Institution of, at the Technical College, **Huddersfield.** 7 p.m. J. Ward, B.SC., PH.D., "**Recent Developments in Stress Analysis by Polarized Light.**"

Photographic Society, Royal, 16 Princes' Gate, S.W.7. 7 p.m. Professor G. I. Finch, M.B.E., F.R.S., "**Electron Diffraction and Surface Structure.**"

Town and Country Planning Association, 28 King Street, Covent Garden, W.C.2. 1.15 p.m. D. B. Williamson, B.SC., "**New Beginnings and New Towns.**"

University of London, King's College. 5.30 p.m. M. le Gouverneur Laurentie, "**Developments in Colonial Administration by European Powers.**" (Lecture III).

At School of Slavonic and East European Studies. 6 p.m. Andrew Rothstein, B.A., "**The History of the Soviet State.**"

FRIDAY, NOVEMBER 29..Dyers and Colourists, Society of, at the St. Enoch Hotel, **Glasgow.** 7 p.m. J. Starkie, "**The Stripping of Dyed Textiles by the Use of the Hydrosulphite Compounds.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester, 3.** 6.30 p.m. Professor C. B. Fawcett, D.SC., "**A Comparison of Interior and Marginal Regions.**"

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. F. M. Green, O.B.E., and J. E. Wallington, B.A., "**Aircraft Propulsion.**"

SATURDAY, NOVEMBER 30..Chemical Engineers, Institution of, at the College of Technology, **Manchester.** 3 p.m. K. A. Sherwin, "**Concentration of Caustic Soda Solution.**"

MONDAY, DECEMBER 2..Mechanical Engineers, Institution of, at the Neville Hall, Westgate Road, **Newcastle-upon-Tyne.** 6 p.m. W. G. A. Perring, "**The Place of the Model in Aeronautical Research.**"

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4732 *FRIDAY, DECEMBER 6th*, 1946 Vol. XCV

MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

ORDINARY MEETING

WEDNESDAY, DECEMBER 11th, at 5 p.m.—"PLANNING RESEARCH FOR INDUSTRIAL DESIGN". By John Gloag, A.R.I.B.A. Sir Charles Tennyson, C.M.G., Chairman of the Central Institute of Art and Design, in the Chair.

DOMINIONS AND COLONIES SECTION

TUESDAY, DECEMBER 17th, at 2.30 p.m.—"THE WORK OF THE RHODES TRUST". By the Right Hon. Lord Elton, Secretary, Rhodes Trust. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., in the Chair.

THOMAS GRAY TRUST LECTURE

MONDAY, DECEMBER 9th, at 5 p.m.—"MARINE LIFE-SAVING APPLIANCES FOR THE MERCHANT NAVY AND FISHING FLEETS". By Captain J. C. Taylor, Principal Officer, Marine Surveyor's Office, Ministry of Transport.

Lecture II. Buoyant apparatus, lifebuoys, lifejackets and line-throwing apparatus.

The lecture will be illustrated by lantern slides.

DR. MANN JUVENILE LECTURES

The two customary Juvenile Lectures will be given in January, under the Dr. Mann Trust. The lectures will be suitable for children of twelve years and over. The details are as follows :

WEDNESDAY, JANUARY 1st, at 2.30 p.m.—"THE CHILDREN'S HOUR". By Derek McCulloch ("Uncle Mac"), Children's Hour Director, B.B.C. (Illustrated by recordings and demonstrations).

WEDNESDAY, JANUARY 8th, at 2.30 p.m.—"THE STORY OF GLASS". by J. H. Partridge, B.SC., PH.D., of the Research Laboratories, General Electric Co., Ltd. (Illustrated by a sound film and demonstrations).

Refreshments will be provided after both meetings.

Tickets will shortly be available and Fellows are entitled to apply for three for each lecture (admitting one adult and two children). A sufficient number of tickets to fill the room on both occasions will be issued in the order in which applications are received and the issue will then be discontinued. Fellows desiring tickets are therefore advised to apply to the Secretary as soon as possible, stating the number required and the date or dates on which admission is required.

"YOUTH LOOKS AT BRITAIN"

COMPETITION FOR POSTER DESIGN

The Council of the Royal Society of Arts, together with the Travel Association of Great Britain and Ireland, are organising a national poster competition in order to encourage artistic talent among the youth of Great Britain and to stimulate an interest in travel.

The competition was initiated by the National Association of Girls' Clubs and Mixed Clubs, and is supported by most of the recognised youth organisations.

The subjects for design are: (*a*) an original travel poster to attract people to any particular locality in Great Britain, and (*b*) an original poster to advertise any forthcoming indoor or outdoor event or entertainment.

Competitors are classified into three sections, those belonging to youth organisations, students of art schools, and day and boarding school pupils. Within each section there will be two age groups, one from 16 to 18, and the other from 19 to 20.

More than 30 prizes have been offered, to a value of over £600—either in cash or holiday vouchers—by members of the Travel Association.

A first prize of the value of £50, with second and third prizes of £25 and £10 respectively are offered in the higher age group. In the lower age group there will be first prizes of £25, with second and third prizes of £10 and £5 respectively. Additional special merit prizes will also be presented for the best poster in each age group.

The Council have appointed the following Judges for the Competition:—(*a*) *Travel Poster*: Cuthbert Graseman; Anna Zinkeisen, R.O.I., R.D.I.; Fred Taylor, R.D.I. and R. A. L. Hartman (representing the Travel Association): (*b*) *Entertainment Poster*: Jack Beddington; David Low; Milner Gray, R.D.I. and R. A. L. Hartman (representing the Travel Association).

It is hoped to arrange for an exhibition at home and abroad of prize-winning and other selected designs at the conclusion of the competition.

The closing date for the competition is March 31st, 1947. Further particulars and entry forms are available on application to the Secretary of the Society.

FOG DISPERSAL

by A. C. HARTLEY, C.B.E., M.I.C.E., M.I.MECH.E., *Chief Engineer of the Anglo-Iranian Oil Co., Ltd., and late Technical Director, Petroleum Warfare Dept.*

Second Ordinary Meeting, Wednesday, November 13th, 1946

The Right Hon. GEOFFREY LLOYD, *late Minister in Charge, Petroleum Warfare Department, in the Chair*

THE CHAIRMAN: You can well imagine what a thrilling job it was, during those days in the war, to take on the responsibility of trying to find a method of clearing fog, particularly when one realised what it meant to the safety as well as to the morale of so many of our bomber pilots.

I remember that practically the first thing that I did was to get hold of the papers in connection with all the meetings since the first World War of the Meteorological Sub-Committee of the Aeronautical Research Committee. On reading through those Minutes I was immediately encouraged, because a very large number of ideas had been put forward; but, as I could see at once, owing to the conditions of peace-time working, the

scientists and other experts concerned had not been able to push forward vigorously enough; whereas I knew perfectly well that on the directive that we had from Mr. Churchill, we were going to push forward with considerable vigour, and, incidentally, to spend a lot of money, if necessary, because of the operational importance of the work.

After that, as far as I was concerned, I had two main ideas. One was that, since most of the Government research organisations were so fully occupied, the right thing to do was to put out large blocks of the work to big firms with good research organisations, which could push hard along their separate lines so long as the whole of the work was co-ordinated. We were very fortunate in getting Sir Harold Hartley, as Chairman of the Scientific Committee, to undertake that co-ordination. Without such guidance, it would, of course, have been rather dangerous to have devolved so much upon individual units. The other thing that I noticed was that, in the consideration that had been given during the war to this problem, the various people concerned—the pilots, the administrators, the scientists and the engineers—were at some distance apart in the consideration of the problem. What I hoped to do was to bring them closer together and to get them to work as an integrated team. I think that, as a matter of fact, we succeeded in doing this, and that it was one of the reasons why we were successful.

The problem of choosing the right engineer was a very difficult one. I might say at this point that whilst I will not be behind anyone in my admiration for scientists, I will be foremost with anybody in my admiration for the engineers of this country. Luckily I knew what Mr. Clifford Hartley had done in the development of the Pluto pipe-line, which, of course, at that time was secret, and I felt that here was a man who had the creative spark of the inventor. So I went along to the Chairman of the Anglo-Iranian Oil Company and I said: " Can you give us more of the services of Mr. Hartley for this new job?" You will hear this evening how he set about it.

There is only one other thing that I want to say. We were very delighted with this work because we felt that, in addition to its war-time importance, it would be one of the few things that we were doing that might have a constructive use in peace-time conditions in relation to civil air transport. As we all know, civil air transport needs regularity and safety, perhaps above all things. Owing to the weather in this country—with the exception of the Aleutian Islands, it is, I think, the foggiest island in the world—we have a special need for it. I have always regretted very much that the Government decided not to go on with the installation which was more than half completed at Heathrow, because, after all, we want Heathrow to be a first-class world airport. I believe that in a foggy climate like ours, such an airport, if it is to achieve that rank, should have fog-clearing apparatus. What is, I think, required is that there should be a careful estimate of the cost of operating Fido under peace conditions, bearing in mind that the latest Fido designs—which were the work of numbers of those whom we see here present, Mr. Hartley and others—made considerable economies possible because it enabled the apparatus to idle for long periods at very low cost, and be turned up quickly for the landing of aircraft, after which it could be turned down again. I think that what is needed is a comparison of the cost of operation under these circumstances of a modern Fido apparatus, first, with the loss which is involved in delay and abandonment of air services, and, secondly, with a reasonable insurance charge against serious accidents.

I am very glad to see the Minister of Civil Aviation here this evening, and we are very grateful for his interest. I would like to appeal to him and to the Prime Minister to order a re-investigation of the question as to whether Fido could not be installed at Heathrow. I would ask them to do it now, and not to wait until their hands may be forced by a number of serious accidents. I am now going to call on Mr. Hartley.

Mr. HARTLEY then read the following paper:

The start and development of Operation Fido, *F*og *I*nvestigation *D*ispersal *O*perations, were in many ways similar to the start and development of Operation Pluto, which I had the privilege of describing to you in a paper a year ago.

In both cases Mr. Geoffrey Lloyd, at the time Secretary for Petroleum, received a clear statement of an urgent operational need and, by enlisting the aid of engineers and scientists, large commercial firms and Government Departments, Institutions and the Services, produced a completely successful solution. I have no space to deal in detail with the more scientific and technical aspects of the development, but I hope by dealing with the broad outlines of the experimental and operational stages to make clear the remarkable collaboration and combined effort which enabled more than 2,500 Allied aircraft with their crews of more than 10,000 airmen to be landed safely by Fido—often in conditions of dense fog.

During 1941 and the spring of 1942 the R.A.F. greatly increased their bomber offensive and suffered an increasing number of casualties owing to accidents when landing in fog, as well as losing a large number of potential flying hours owing to fog or threat of fog. The Prime Minister was deeply concerned, and Lord Cherwell, who had drawn attention as far back as 1921 to the possibility of dispersing fog over airfields to assist landing, urged that fog dispersal experiments which had been abandoned in May, 1939, should be started again and be proceeded with as long as there was the slightest chance of success. The prevailing expert opinion at the time, both inside and outside Government Departments, did not hold out any hope, but Mr. Churchill, after consulting the Air Staff and the Ministry of Aircraft Production, decided to entrust the task to the Petroleum Warfare Department.

On the 26th September, 1942, Mr. Churchill addressed a personal minute to Mr. Geoffrey Lloyd, the Minister who was responsible to him as Minister of Defence for the Petroleum Warfare Department, phrased as follows:—

> " It is of great importance to find means to dissipate fog at aerodromes so that aircraft can land safely. Let full experiments to this end be put in hand by the Petroleum Warfare Department with all expedition. They should be given every support.
>
> (Sgd.) WINSTON CHURCHILL."

Mr. Lloyd sought the assistance of many large firms and they seconded engineers and scientists to form the Fido team, with individual engineers and scientists and with personnel from the R.A.F. and the Meteorological Office. The Director-General of the team was Major-Gen. Sir Donald Banks, K.C.B., D.S.O., M.C., T.D., and I had the privilege of being loaned by the Chairman of the Anglo-Iranian Oil Co., Ltd., Sir William Fraser, C.B.E., to become its Technical Director. Mr. E. G. Walker, M.I.C.E. M.I.MECH.E., was appointed Chief Engineer.

Owing to the extreme urgency, Mr. Lloyd decided that any method which offered the slightest chance of early success was to be tried out on the full scale, even before the technical literature had been fully combed, and while conferences of engineers, scientists, meteorological experts and experienced pilots were still taking place with a view to the initiation of a full programme of research and experiment.

Preparations were at once made to provide full-scale facilities for trying out ideas at the P.W.D. Experimental Stations at Langhurst and Moody Down, and in an uncompleted Metropolitan Water Board reservoir at Staines, where fogs were likely to be prevalent and where the P.W.D. were already testing flame weapons. Preparations were also made for small-scale experiments in a wind tunnel quickly designed with the help of the National Physical Laboratory and constructed at the

Earl's Court ice-skating rink, where artificial fogs could be produced. Fog chambers were erected by the Gas Light & Coke Co. at Fulham, by the Imperial Chemical Industries at Billingham, and by the Imperial College at South Kensington. The L.M.S. Railway Company started experiments at Derby and the General Electric Company at Wembley.

It became clear in the first few days that of all the methods previously tried here and in the U.S.A., including the use of supersonic waves, electrical discharges, absorption of moisture by chemicals, drying by refrigerating and outdoor air-conditioning apparatus, the method tried by the Royal Aircraft Establishment of using direct heat offered the best chance of success. Experiments were continued with some of the other methods, but none was sufficiently developed to be installed at an airfield and in the remainder of this paper I will deal only with direct heat methods.

The Royal Aircraft Establishment produced samples of the burners used and full reports of their tests, in which simple Four Oaks agricultural atomising spray type burners had been arranged in two lines at right angles, each 600 feet long, to burn four gallons per yard per hour of a mixture of 80 per cent. alcohol and 20 per cent. petrol. The addition of alcohol was necessary to avoid excessive smoke, but involved a reduction of heat output per gallon burnt compared with petrol. A series of experiments carried out between December, 1938, and May, 1939, had shown small improvements in visibility during fog, and the Director of the Meteorological Office had estimated that a five-fold increase in heat output would be necessary for satisfactory dispersal. It was the incomplete clearance effected and the high fuel consumption anticipated which had led to the abandonment of the scheme on the outbreak of war.

The need in the autumn of 1942 was, however, so urgent that steps were immediately taken to obtain large numbers of the Four Oaks burners and erect them in full-scale installations at Moody Down and at Staines, to be capable of burning twenty or more gallons of petrol per yard per hour. One set at Moody Down was designed to be portable and to be operated by a P.W.D. Royal Engineer Detachment, so that it might be moved to any foggy area, because one of the greatest difficulties of previous investigators had been to find fog with which to experiment. The P.W.D. therefore cast their net wide, including the Thames Valley and a foggy area near Derby, and as will be explained later, they also developed methods for obtaining results in clear air by taking temperature and wind speed observations.

Meanwhile the Air Officer Commanding-in-Chief, Bomber Command, (Marshal of the Royal Air Force Sir Arthur Harris, G.C.B., O.B.E., A.F.C.) had stated his initial requirement for operational purposes as the clearance of a space 1,000 yards in length by 100 feet high over the runway, with about half the length before and half after the touch-down. Major R. H Mayo, of Composite Aircraft fame, and a friend of my Royal Flying Corps days, introduced me to Air Vice-Marshal D. C. T. Bennett, C.B., C.B.E., D.S.O., then the Group Captain in command of the first Pathfinder Group, and, without waiting for the results of any experiments, he agreed on the 10th October, a fortnight after the start of the investigation, that we should put in parallel lines of burners on each side of a runway at one of his airfields.

Consideration of risk to aircraft that might swerve off the runway and be damaged by the burners, even when not in use, coupled with the need for the burners not to be too far from the edge of the runway to be effective, led to agreement that they should be 50 yards from each edge of the normal 50-yard-wide runway. It is interesting to note that later investigations and research showed that this was the best compromise between the need for the two rising columns of hot air to be close enough to pull together to deal with stagnant conditions and yet be sufficiently wide apart for the up-wind column to rise, in cross-drift conditions, sufficiently to give the required 100-feet clearance over the runway. It was adopted as the basic arrangement for Fido installation. (Fig. 1.)

A scheme was completed two days later at the Anglo-Iranian Research Station to install two parallel lines of burners on each side of the runway, each to burn petrol at 12 gallons per yard per hour, thus providing for up to six times the original R.A.E. experimental rate. Dr. A. O. Rankine, F.R.S., of the Anglo-Iranian Oil Company, who had joined the Fido team and had by then completed a survey of

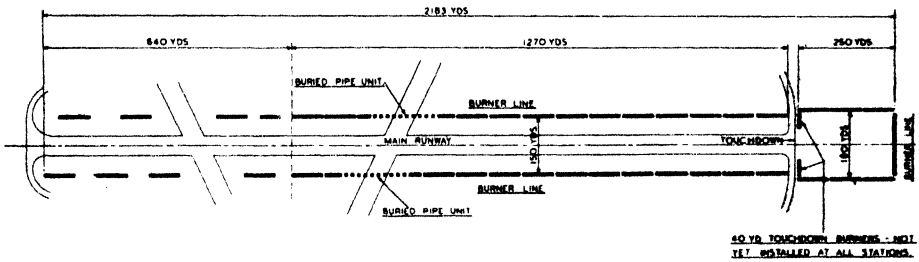


FIG. 1.—*Basic arrangement for Fido installation*, 1943

the available data, confirmed that this heat output would be of the right order and was in accordance with Prof. Brunt's theoretical calculations.

Arrangements were made at once for Messrs. William Press to undertake the construction work at Graveley and to use petrol-engine-driven pumps, cylindrical tanks and pipes taken from the Flame Defences developed by the Petroleum Warfare Department on South coast beaches, and no longer required as the risk of invasion had passed. On Saturday, the 17th October, three weeks after the Prime Minister's minute, construction work was actually started, but with the clear understanding that the burners had not then been tested and would undoubtedly need modification.

Meanwhile Mr. F. M. Birks, C.B.E., Chief Engineer of the Gas Light & Coke Co., Ltd., had developed simple continuous braziers made with steel scaffolding, expanded metal and corrugated iron sheeting for burning coke (Fig. 2), and with his staff and maintenance departments, installed long lines of them at Staines to take advantage of coke's smokeless combustion. He and his staff also helped to instal the petrol burner installations there.

The work at Moody Down and at Staines was sufficiently advanced to experiment on the 4th November, 1942, with the first fog experienced since the beginning of the investigation, and very interesting results were obtained. A definite clearance was obtained at Moody Down between two lines of burners 160 yards long and

100 yards apart in a thick but fairly shallow radiation fog, although the effect was somewhat marred by smoke. At Staines later in the morning the lighting of a 400-yard length of coke braziers yielded remarkable first results. A large clearance downwind was obtained at ground level, but the clearance above the ground was less owing to the low heat output obtained, equivalent only to about four gallons of petrol per yard per hour. The petrol burner installation was then tried, but excessive smoke again marred the clearance.

As a result of this early success, the Air Ministry agreed to an experimental coke-burning installation at the bomber airfield, Lakenheath, and all possible steps were taken to improve the design of braziers to enable the heat output to be substantially



FIG. 2.—*Coke braziers at Staines, November*, 1942

increased. Efforts were also concentrated on reducing the smoke still produced by the petrol burners even when large percentages of alcohol were used. Alcohol was obtainable for experimental purposes, but it could not be obtained in sufficient quantity for operational use, and it was urgently necessary to obtain clear burning with petrol alone.

It was by now very obvious that Fido must be designed for easy installation at existing airfields without interfering with their operational use if it was to be of any real benefit to the R.A.F. within a reasonable time, and it must therefore be kept as simple as possible and require the minimum of site work. The slogan was—"Commission Fido even one night earlier and he may just catch a fog and save aircraft". Elaborate installations using air under pressure for atomising petrol, or for providing heated and dried air through underground ventilation ducting, were

therefore out of the question and research was pressed forward to produce results with the simple pumps and pipes alone available.

Many forms of cowls were tried with the Four Oaks burners, but these added complications and increased the obstruction offered to aircraft, without producing much improvement without alcohol. During trials with the Four Oaks burners early in November I had noticed that less smoke was produced from some of the nozzles after they had been operating for some time, but that the size of the flames was also reduced because some of the petrol was being vaporized on its way up to the burner nozzle and was being burnt as gas. Attempts were made deliberately to vaporize the petrol in various forms of burners, both in field and laboratory experiments, but these were complicated and not at all promising. I thought, therefore, of increasing the size of the hole in the Four Oaks burner to produce sufficient heat after vaporization had begun, tolerating the extra smoke which would be produced until that occurred, but I then realised that the cowls, nozzles, and even the standpipes, could be discarded if small holes were drilled in the supply pipe, thus making it the burner pipe.

Holes about 3/16ths of an inch in diameter were at once drilled about every six inches along the top of the 1½-inch supply pipe, and the petrol pumped through the holes was ignited. Large volumes of smoke were produced for the first few minutes but the petrol burning around the pipe then produced sufficient heat to vaporize some of the oncoming petrol and clear burning was obtained at many of the holes. This was a very promising development, but it was seen that much more heat was required to maintain complete vaporization. The petrol was therefore pumped through extra supply pipes laid alongside the burner pipe so that it would be heated by radiant heat from the flames. Many different arrangements were tried before the type known as HAIGAS (*H*artley *A*nglo-*I*ranian *Gas*) was adopted.

In this type the delivery pipes were laid round the burner pipe so that the oncoming petrol had to pass backwards and forwards through three 50-yard lengths before entering the burner pipe. To provide for expansion and contraction, the method successfully used on the Anglo-Iranian oil pipelines was adopted of making a sharp bend in all the pipes every few yards alternately in each direction and anchoring the pipes only at the middle of each straight portion, thus leaving the angles free to flex like knees. The HAIGAS was protected by shallow corrugated iron screens to minimise the effect of wind on the burning but, even so, offered far less obstruction than the original Four Oaks arrangement. These burners were installed at Graveley airfield and, owing to the great increase in heat output, only one line instead of two was required on each side of the runway.

Each 50-yard burner length was at first hand-controlled by an airman who watched a gauge and tried to maintain the required pressure of about 18 lb./sq. inch by use of a valve. This was found impracticable and the use of automatic pressure-reducing valves and automatic shut-off valves was later developed to enable the installation to be controlled from the pumphouse.

Meanwhile experiments at Staines on all possible occasions, mostly at night with the Ministry of Home Security's authority to ignore the blackout, and in the Earl's Court wind tunnel, had shown that fogs would always be cleared if the temperature of the air could be increased by 4°–7°F. Special instruments were developed

with the help of the National Physical Laboratory and the General Electric Company for reading temperatures and wind speeds, and these enabled valuable work to be done without fog on the model scale in the wind tunnel, and, with the aid of 100-foot fire ladders borrowed from the National Fire Service, on the full scale in clear but otherwise suitable conditions at Staines. Confirmation was obtained that the heat produced by burning about 20 gallons per yard per hour would clear fog under all likely conditions, provided a complete rectangle of burners with 150 yards between the long side lines could be used, but that any gaps in the side lines of more than about 5 yards might permit serious fog

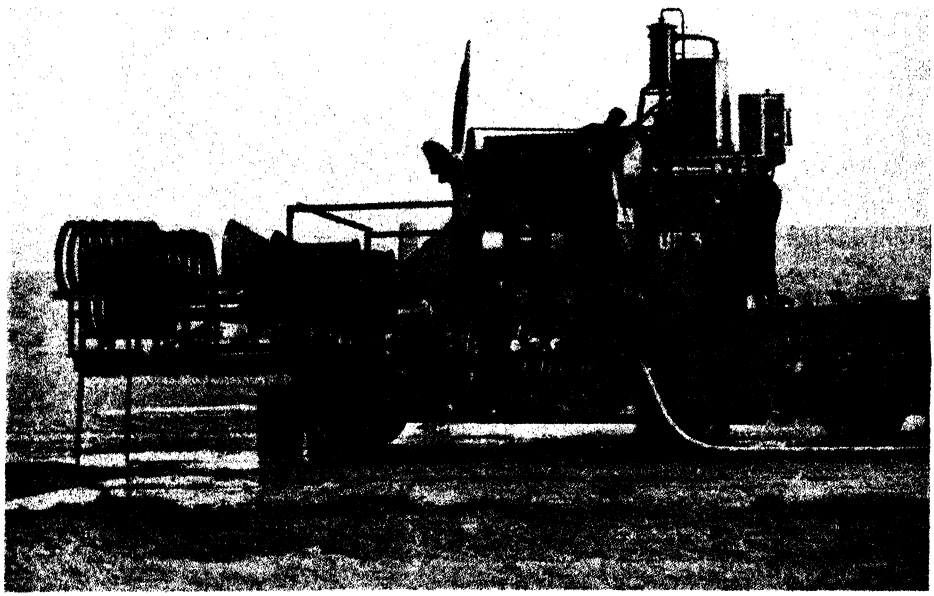


FIG. 3.—*Heat blower*, 1943

intrusion, and that an open end might also allow fog to come in for a few hundred yards.

In all operational airfields there are intersecting runways, which cross the main runway, and across which above-ground burners cannot be permanently installed. At first HAIGAS burners were arranged on swing gates, which could be swung across these gaps when Fido was to be used, but a special form of Intersecting Runway Burner (I.R.B.) was later developed.

Meanwhile considerable difficulty was being experienced in getting greater heat output from the coke braziers without using firebricks and, with the greatly improved results obtained with the HAIGAS burner, it was decided to abandon the coke installations and avoid the very great difficulty of transporting and handling the vast quantities of coke which would have been required and the handicap of slow ignition and extinction.

Experiments were made by the Imperial Chemical Industries during this period with a heat-blower, comprising an aeroplane engine with a pusher propellor arranged to drive air heated by large vaporizing petrol burners across the runway. (Fig. 3.) The trials showed that a very large number would be required, thus causing serious obstruction, and, as specially constructed roads alongside the runways would have been necessary to get them into position, and for their maintenance, they were abandoned as a means of providing complete installations. Some were retained however, for closing the open end of a HAIGAS installation by blowing heated air



FIG. 4.—*Experimental HAIGILL Burner, February*, 1943

across the runway, until Imperial Chemical Industries developed the Rapex (rapidly extinguishable) burner, to be described later, for this purpose.

The Graveley Fido was ready for use early in 1943, but it was not until the 18th February that conditions were suitable for a flying test. There was low visibility without actual fog, and Air-Vice-Marshal Bennett decided to prove whether the glare and turbulence produced by Fido would cause difficulty in landing; in other words, he wished to prove whether he could land in spite of Fido. He flew his Lancaster low along the runway first and then made an excellent landing. He reported that the glare had at first looked formidable, but that once within Fido, conditions were like daylight, and the effect of the turbulence had been little more than that of a normal bumpy day on even a small aircraft. The test was considered

to be sufficiently successful for immediate steps to be taken to put in another Fido, and Downham Market in Norfolk, another Pathfinder airfield, was chosen.

Meanwhile experimental work had been continued and efforts were made to improve the performance of the HAIGAS burners sufficiently to avoid the need for the screens, by drilling some side holes in the burner pipe to provide more direct heating of the vaporizer pipes. Some improvement was made, and this led Mr. F. Gill of the Anglo-Iranian Oil Company to suggest the design which became the HAIGILL and eventually replaced the HAIGAS. A 2-inch diameter preheater pipe about 20 yards long was supported by cast-iron spreaders at the apex of a 7-inch sided equilateral triangle with two 1¼-inch burner pipes fed from it forming the base. (Fig. 4.) The holes were drilled in the two burner pipes so that the centre line of the jets issuing from them just missed the edge of the preheater pipe, allowing under stagnant conditions for about half the flame to wrap round the preheater.

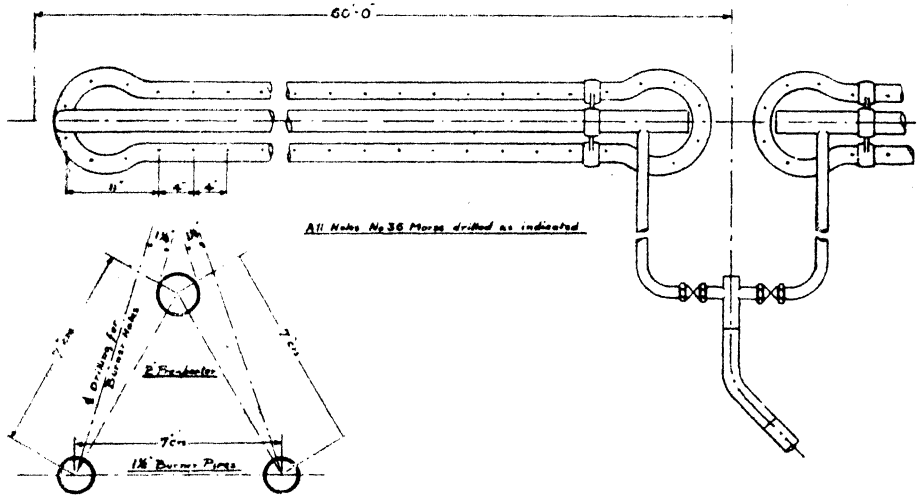


FIG. 5.—*Diagram of HAIGILL Burner*

(Fig. 5.) The same heating as in stagnant conditions was thus obtained in side winds, because the upwind flame was blown on to the extent to which the downwind flame was blown off the preheater.

The burner pipes formed a complete loop on the first design but, to avoid distortion due to uneven expansion, they were later made in two straight lengths with the feed at one end only, leaving the other ends free to expand separately. Outputs up to 40 gallons per yard per hour proved possible with completely smokeless burning and without side screens, so the problem of smokeless burning with simple pipes easy to install and with the minimum of obstruction was at last solved.

Burners on swing gates for closing the gaps across intersecting runways were proving unsatisfactory and experiments were made at Staines to increase the vaporization of the standard HAIGILL by adding more preheater pipes, to provide sufficient surplus gas to feed a burner pipe buried in a shallow trench. Difficulties were at first experienced from recondensation of the gas along the pipe, causing spill of petrol and smoke, but these were overcome except during the start-up period, and

the design became the I.R.B., or Intersecting Runway Burner. (Fig. 6.) Spill was prevented from damaging the runway by arranging two burner lines to operate from both sides of the intersection, one being too short to reach the actual runway and the other one long enough to go right across and overlap the short one.

No opportunity arose for a try-out at Graveley in fog until the 17th July, 1943. Visibility on that day was between 100 and 200 yards, and Fido completely cleared the fog for an aircraft to take off and land several times. Visibility fell immediately to 100 yards when Fido was turned off. This success was reported by Mr. Lloyd to Mr. Churchill and resulted in instructions being given by the Air Ministry for the immediate construction of six more Fidos on operational airfields.

The Fido team prepared a complete specification incorporating petrol storage



FIG. 6.—*Experimental Intersecting Runway Burner (I.R.B.), 1943. The vaporiser is in the foreground, the trenched burner pipe in the distance*

tanks of about 2,000 tons capacity (to be fed either by road tankers or by pipeline from rail tank-car sidings near by), petrol-driven pumping plants, control house, buried petrol supply pipes and HAIGILL and I.R.B. burners of simplified type for easy construction and erection. Mr. E. R. Cartwright, C.B.E., Chief Engineer of the Shell Refining & Marketing Company, acting as agent of the Petroleum Board, undertook the direction of the construction of the new Fidos by the team of contractors he had used for the first part of the construction of the 1,000-mile English petrol pipe system. Work was started in August, 1943, and successful landings were made during November at several stations by aircraft returning from operations in dense fog; the first by four Halifaxes returning from the Ruhr on the 19th in a fog of only 100 yards visibility.

Mention must be made here of the splendid contribution of Mr. Lawson and Mr. Caffery and their staff in the Petroleum Board in providing equipment and

adequate supplies of petrol at all times for all experiments, tests and operations.

The Air Ministry then gave instructions for seven more Fidos to be constructed, of which three were to be the special rescue stations, Carnaby, Woodbridge and Manston. Operational experience with those so far completed confirmed that with ordinary inland fog and with the normal runways 50 yards wide, adequate clearance could be relied upon. One of the first eight stations chosen was, however, St. Eval, near the Cornish coast, where sea fogs drifting at more than 15 miles an hour were frequent. Fido was particularly necessary there to enable Coastal Command to maintain the submarine patrol, and small-scale experiments were carried out at Earls Court to determine the heat output and arrangement of burners required. They indicated that a second line of burners should be used 75 yards outside the normal Fido side lines, so that additional heat could be generated further away from the centre of the runway, to enable the cleared air to rise to the required height over the runway in spite of the speed of drift. Fido was put in to this design and was not only successful in enabling returning aircraft to land, but also in clearing fog for them to take off on urgent operational duties. The success of Fido at St. Eval is illustrated by the following example.

During one of the take-off operations a Lysander pilot, whose wireless was out of order and who was having difficulty in finding an airfield, saw the glow and landed on the cleared runway just after the last machine had taken off. The station authorities did not, however, know of its presence, and it so happened that this landing coincided with the order to turn off the installation. The speed of drift was so great that the pilot immediately found himself lost in fog on the runway, and the density was such that it took him two hours to find the control tower.

The three airfields, Carnaby, Woodbridge and Manston, were the special emergency rescue stations with runways 250 yards wide and 3,000 yards long. The extreme difficulty of clearing these wide runways which prevented the burner lines being less than about 270 yards apart, was immediately obvious, but Bomber Command attached the greatest importance to the clearance of fog from these stations, to make them available at all times for the rescue of damaged or distressed aircraft. Model scale experiments were therefore made at Earl's Court, using a scaling formula developed by Dr. Rankine in consultation with Sir Geoffrey Taylor, F.R.S.; and it was proved that if the normal 20 gallons per yard per hour for 150 yards spacing were increased to 55 gallons, clearance would be obtained in stagnant conditions at 270 yards spacing. As HAIGILL burners were already capable of burning up to 40 gallons per yard per hour, two rows 20 feet apart put down at each side of the runway gave an ample margin over the 55 gallons. Four rows were put down at the approach end and short burners to mark the actual touch-down position. Gaps had to be left on one side for damaged aircraft to be pulled off the runway, and each was covered by a single short I.R.B. modified to consume 55 gallons a yard an hour.

Imperial Chemical Industries had suspended work on the heat blowers already described for sealing the open or further end of a runway, and developed the Rapex or rapidly extinguishable type of burner. This was similar in principle to the I.R.B. in that sufficient heat was generated off the runway to supply a burner line

built into the runway but, in addition, means were provided for diverting the gas to a burner line off the runway and for shutting down the runway burners by the manipulation of control valves.

Thus, if difficulty was being experienced due to fog intrusion at the normally open end, this Rapex line could be operated until the incoming aircraft had almost touched down, and then put out in two or three seconds long before the aircraft



FIG. 7.—*Pair of HAIFOX portable burners, back to back*

reached it. This burner was installed and successfully tested, but the fog intrusion in practice was never sufficient to necessitate its use operationally.

In one foggy afternoon in December, 1944, Woodbridge enabled more than ninety aircraft, mostly Fortresses, to land; a striking tribute to the soundness of the design developed from model scale experiments. Landings were frequently made at intervals of less than two minutes.

The U.S. Navy and Army Air Forces were kept fully informed of all Fido

developments; and during a visit to America in February to June, 1944, I was able to assist in the design of a Fido for the Navy in the Aleutian Islands, and for the Army at Wright Field, Dayton. I saw trials of the latter before leaving, and the former operated on one occasion to let fighter aircraft take off to escort the late President Roosevelt on one of his journeys by sea. We were indebted to our American friends for the provision of their open type of highway flare for automatic light-up of burners, which had previously been by hand torches or by matches.

After the successful invasion of the Continent, the Tactical Air Force, who had made good use of home Fido installations, were moved forward to France and Belgium and were keen to have the benefit of Fido there. In anticipation of this, a complete transportable installation had been developed by Mr. Fox of the Anglo-Iranian, at Staines, using HAIFOX burners like miniature I.R.B.'s in which sufficient gas was developed in a six-coil vaporizer 7 feet 6 inches long to supply a burner pipe 2 inches in diameter and 76 feet long. These vaporizers were laid back to back (Fig. 7), so that each pair dealt with 180 feet of runway. The whole of the plant was designed for easy transport, if necessary by air, and for the minimum erection effort on site. When instructions were received from the Air Ministry to provide an installation for Air Vice-Marshal Sir Basil Embry, K.B.E., C.B., D.S.O., D.F.C., A.F.C., 2nd T.A.F. 2 Group at Epinoy in December, 1944, all was ready and, with the help of the R.E., the Canadian R.E., and the R.A.F. Electrical and Mechanical Engineers, it was completed, in spite of extreme difficulty with snow and bad weather.

A simplified form of small HAIFOX burner, designed for operation with petrol pumped by hand from barrels, was also developed and was used to a considerable extent by the R.A.F. and U.S.A.A.F. in pairs forming an arrow to indicate the direction of landing, in poor visibility where Fido was not available, or when conditions were not bad enough for the use of the whole installation.

I have dealt so far with the burners actually used before VE-day on operations and, as I have already explained, they were all designed for the easiest possible manufacture and for rapid installation with minimum civil engineering work on airfields already in use. The burners were therefore necessarily above ground and offered some obstruction, although small, to any aircraft that might accidentally cross them, but were of such a design that it was they and not the aircraft which suffered damage, even in the case of such a light aircraft as a Spitfire.

Nevertheless, the P.W.D. decided early in 1944 to press forward with designs of more permanent types which would eliminate all obstruction and which would approach as nearly as possible to the ideal of press-button control to enable, in the interests of economy, only those sections actually required to be selected and ignited automatically. Two lines of development were actively pursued; one, the Hades, was developed from the I.R.B. and Rapex burners by Imperial Chemical Industries at Staines, under the direction of their Mr. W. T. Moore. In the final design the trenched vaporizer was 130 feet long and fed 650 feet of trenched burner line (Fig. 8), and it was capable of burning up to 55 gallons of petrol per yard per hour of its length. A method of automatic ignition and control was proved at Staines. Burners of this type were installed at Manston to replace the HAIGILL burners, and this station was completed in June, 1945. Both vaporizer and burner-line would withstand the weight of the heaviest bomber without damage.

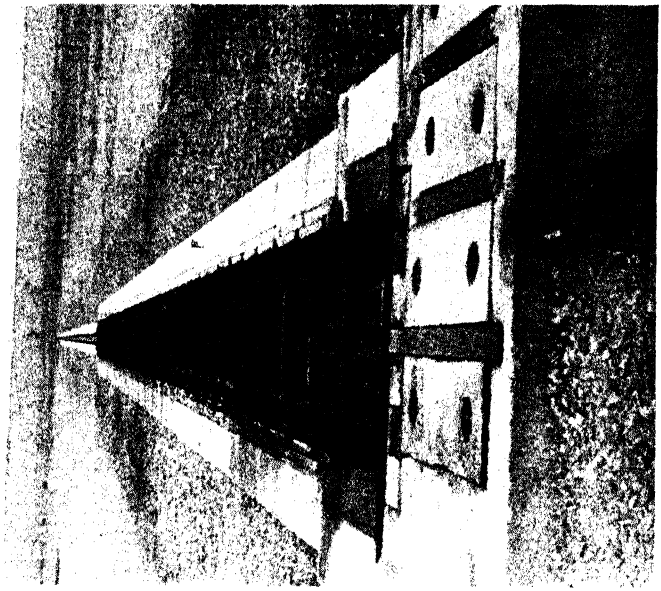


FIG. 8.—*Hades burner installation from vaporizer end*

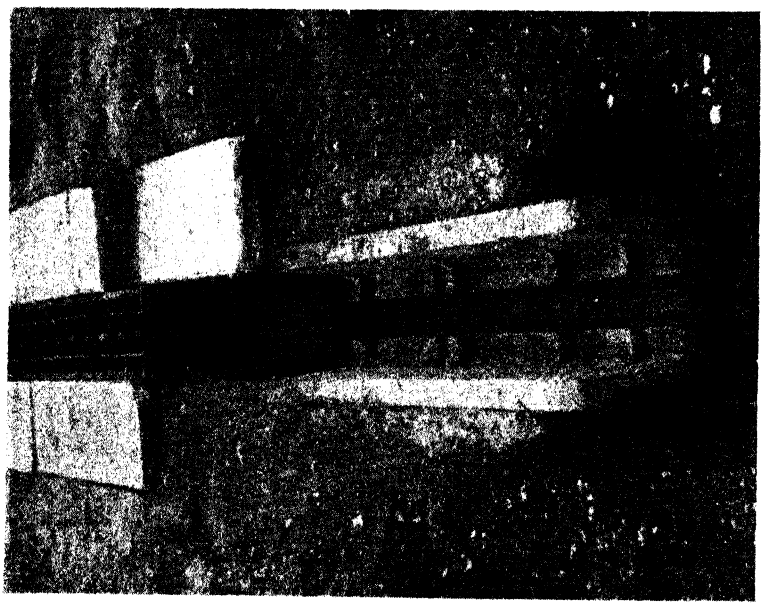


FIG. 9.—*Slot burner system, showing cast-iron troughs, precast heat-resisting concrete troughs and coping slabs, and steel grids*

The second type of below-ground burner was the "Slot". During the intensive development of the types already described, very valuable experimental work had been carried out by Dr. Garner and the Esso European Laboratories group at Belvedere, by Mr. Callender at the P.W.D. Research Station, Langhurst, and by Dr. Lander, Dr. Rosin and Dr. Fehling at the Imperial College of Science, with multiple short-length burners. Experiments were made with some of these in deep slots with the object of keeping the flames below ground, but it proved impossible to get sufficient heat output.

The results were reviewed and further development was undertaken by the Imperial College and General Electric Company groups with the help of Messrs. Babcock & Wilcox. They produced a burner 10 feet long, made of $\frac{3}{4}$-inch diameter pipe, bent in the form of a horizontal hairpin, the lower leg of which consisted of the drilled burner pipe with its petrol vapour jets impinging vertically upwards on to the top leg of the hairpin, this being the vaporizer. The latter contained an inner spray pipe, surrounded by an annular spiral, to prevent distortion. This burner was installed in cast-iron troughs, 8 inches deep, 8 inches wide, with steel grids across the top capable of carrying the load of a bomber (Fig. 9). Automatic control of ignition, of burning-off periods and of time for bringing up to full heat output was developed and this type of burner was installed at the Blackbushe airfield at the far end of the HAIGILL installation. After promising trials, the slot burners were installed throughout the installation and an improved design was developed for Heathrow.

Experience with the hairpin burner, however, showed that varying atmospheric conditions made it difficult for sufficient air to be induced to supply the burner jets, low down in the slots, when they were used in long lines. Smokeless outputs of 20 gallons a yard an hour could not be maintained with certainty. Experiments were therefore initiated at Staines and the HAIFOX type of horizontal coil burners was adapted for use in the slots. In this design, called the HAIFLOT, most of the burner flames rose vertically from and completely clear of the slot troughs and obtained their air above the grids. Vaporization was by a few horizontal jets impinging co-axially upon one end of a small coil vaporizer set longitudinally within the cast-iron troughs and underneath the main burner line and its vertical jets. This design got over the difficulty of overheating also experienced with the hairpin burners when running at low output, because the vaporizer jets when working at low pressure engage fewer turns of the vaporizer coil, thus automatically reducing the heat available for vaporization to compensate for the reduced quantity of petrol to be vaporized. With this type of burner it was found that the slot installations could be controlled and operated indefinitely at any output from 2 to 25 gallons per yard per hour and with a reserve maximum smokeless performance of 40 gallons per yard per hour. They were capable of attaining the 25-gallon rate in eight minutes from the cold state.

The installation of Fido at Heathrow has been suspended, but should a peace-time Fido installation be required it would now be possible to use equipment of great flexibility of output which could be idled indefinitely whenever an aircraft was not requiring it and which, with automatic selection and ignition of the burners

required to meet the prevailing meteorological conditions, would show very great economies in consumption of petrol over the war-time experiences.

I will now show you a coloured ciné film showing the development and operation of each type of burner, and shots from the air of Fido in operation at Woodbridge and Manston. You will also see shots of the clearance effected at Graveley under stagnant conditions, and the maintenance of that clearance for a long time by the descent of the heated air after Fido was shut down.

There is no space to detail the very remarkable results obtained by the use of Fido, but Air-Marshal Harris has stated that the existence of fifteen stations enabled him to put on sorties in spite of unpromising meteorological reports, and he was able to maintain a continuity of offensive otherwise impossible. The morale of his pilots improved so greatly with the knowledge that there would be no need to bale out on return if their airfield were covered with fog that their tour of duty was appreciably lengthened.

Air Marshal Harris wrote in December, 1944, to Mr. Lloyd to say that they were getting to the stage where Fido was taken as a matter of course and that the numbers of aircraft landed had been, in September, 43; October, 33; November, 261, of which 196 were on the 16th. The greatest contributions to these results were made by the flying control staffs and the Fido crews at the airfields. They had a dreary task maintaining the installation ready for instant action, but were thrilled when they saw fog cleared and aircraft landing safely as a result of their efforts.

I hope I have been able to give some idea of the really remarkable co-operation and wholehearted continued effort on the part of the whole team and their advisers and helpers, inspired and co-ordinated by Mr. Lloyd and Sir Donald Banks, which enabled Fido to achieve so many successes, including that of enabling the fog-bound Pathfinder force in the East Midlands to take off and mark targets to enable the main Bomber Force, most of which was not fog-bound, to take an effective part in stopping Field-Marshal von Rundstedt's offensive. He is quoted as saying, on the 5th May, 1945, that: " The object of the Ardennes offensive was to relieve pressure, take Liege and hold the line of the Meuse. Allied strategic bombing of supply lines caused the failure of the push. Hitler ordered the Ardennes offensive, which was Germany's only chance of averting defeat".

DISCUSSION

Air Chief Marshal Sir CHRISTOPHER COURTNEY, G.B.E., K.C.B., D.S.O.: I really do not think that I can add a great deal to the very illuminating—in more respects than one—talk which we have had this evening. I sat in the Air Ministry and watched, with what pleasure you can imagine, the very rapid progress of the work which was done on Fido by the Petroleum Warfare Department. I need hardly say what a tremendous pleasure it was to see with what vigour the thing was pushed along and with what speed results were obtained. The figures of aircraft definitely saved were very striking. Two thousand five hundred were landed with the assistance of Fido. Not all of these would have been lost if there had not been Fido; but it is quite possible that without Fido a good proportion of them would never have taken off.

I hope that I may be forgiven for supporting Mr. Lloyd's plea that this great war-time development should be harnessed for peace-time application to civil flying. It was a tremendous disappointment to me personally that within a very few weeks of Heathrow being handed over by the Air Ministry to the Minister of Civil Aviation—I am glad to

say that no responsibility for this attaches to the present Minister—the decision was made to discontinue the work, which was very largely complete. To see all that very expensive experimental work thrown down the drain, as it appeared to me, was a matter of great disappointment to me and I am sure to many others. I do most warmly support Mr. Geoffrey Lloyd's plea that there should be a re-examination of the probable costs of operating it. Lately one has had long lines of aircraft held up at Heathrow and unable to leave because of fog, and I cannot believe that the foreign companies would not be prepared to contribute their bit to the costs that might arise.

Sir CECIL KISCH, K.C.I.E., C.B.: I had the pleasure, in a humble and non-technical position,of being associated with our Chairman, Mr. Hartley and others here in this work. I can truthfully say, after an experience of over 35 years in the public service, that I have never known a big job undertaken with more inspiring determination than this was undertaken by Mr. Lloyd and by the team of technical and other experts who were associated with it. One of the points which very much impressed me, was the quickness of Mr. Hartley to put his finger on the spot, when he said from the very beginning that this thing would be solved by heat and petrol. I recall the day when Mr. Hartley said to me what perhaps should have been obvious, that fog generally disappears when the sun emerges, and that it is for the sun's heat one waits to disperse the fog. Mr. Hartley was applying the object lesson of the way in which fog does actually disappear in nature.

I very well remember that we had with us one of Sir Christopher Courtney's officers in the department who had made, at the time when I first knew him, about 75 operational flights over Germany, and I was discussing with him whether there was not any way of getting people to land on instruments and instruments alone, because it was so urgent to get something done. This very distinguished officer told me that if you could give pilots a long enough training they could do it, that he himself had done it with success, but that under war conditions, when pilots had to be turned out very quickly, it was essential to provide something else in order to give them confidence. The human instinct, he said, is such that you want to see where you are going to touch down, and that no one would care to come down on instruments alone except those who had had very special training and experience requiring much longer practice than could be given in war conditions.

Like others, I regret that the pioneer work at Heathrow has been suspended. When I was in the United States recently and there were accidents due to various causes in the Newfoundland area, I wondered if something of the Fido type had been considered out there. Out of six visits by air to that region there was fog on five occasions. The pilot, by skilful seizing of opportunities brought his plane safely down on four of those occasions, and on one occasion he flew on to another place.

In this country, with the eccentricity of our weather, something of the Fido type seems to me necessary on at least one of the principal aerodromes. The maximum safety is essential if flying is going to be developed in the way in which we hope that it will be, and I cannot think that the expense of this aid to safety in emergency should be a deterrent to its installation. At one time I tried to work out for Mr. Lloyd the cost of the Fido installations under war conditions in respect of the quantity of oil that was likely to to be consumed. All the oil at that time arrived in the teeth of submarines and mines. We made calculations, with the help of meteorologists. How often in the year would Fido require to be lit up and for how long? The amount of oil that was likely to be required was astonishingly small, assuming, of course, that the burning was properly controlled.

Brig.-Gen. Sir HAROLD HARTLEY, K.C.V.O., M.C., F.R.S.: The thing that struck me most about Fido was that it was the most perfectly planned piece of co-operation in which I have ever had the privilege to take part. Sir Cecil has spoken of Mr. Lloyd's leadership and what we owe to it, but it was much more than just enthusiasm that he brought to the job. Everything was thought of and planned, and the resources were made available, so that the work was able to proceed at a very rapid rate.

As Mr. Lloyd has said, it was primarily an engineering job, and you will have gathered from Mr. Hartley's exposition the clearness of brain which he brought to it. I admired so the speed with which the engineers dealt with all the difficulties that arose. It is tantalising to-day to look back at the speed with which it was possible to do things in war and the way in which one was able to concentrate in war, without a moment's delay, the best brains in the country. That was, I think, really the key to our success. I think too that it was an extremely good example of the value of getting engineers and scientists working in the closest relation to one another. Sometimes they tend to get a little apart from one another. I am sure that Mr. Hartley will agree with me in this. We owed too a great deal to the way in which Mr. Lloyd always took the big view. He was never afraid. In taking Earl's Court and in doing things on a big scale we always got complete support from him. There is no doubt that the large wind tunnel at Earl's Court, and the scientists working there in daily contact with the progress of Fido, contributed a good deal to the certainty of the large-scale operations and saved a great deal of effort. As I say, it is tantalising to look back at the speed with which this could be done in war, but one realises, of course, that then speed was everything.

There is one point which I do not think has been emphasised quite sufficiently. There were a certain number of people who thought that we ought to go in for non-luminous burners to save petrol and to avoid glare for the pilots. I talked to a good many pilots and the impression left upon me was their appreciation of the way in which Fido relieved the strain and the anxiety as to how they were going to land. They all said: " Keep the luminous burners, because when we see Fido 60 or 70 miles away and we know that we have to come down through the fog it gives us a marker and we know exactly the conditions that we are going to meet."

I would like to add my word of appreciation, both to Mr. Lloyd for his leadership and to Mr. Hartley for the skill with which he directed the whole of the engineering work. I would say that, without exception, it was the most satisfactory organisation in which I have ever worked. The first morning when we cleared the big fog from Staines was one of the most thrilling moments in my life.

Mr. F. M. BIRKS, C.B.E. (Gas, Light & Coke Company): I remember quite well the morning to which Sir Harold refers. He was going to a very important meeting. I got hold of him and said that there was a fog. It was the fog for which we had been waiting for many weeks, and we dashed off down there. When we met Mr. Geoffrey Lloyd and Mr. Hartley coming across the field, they commiserated with us because the fog had lifted just as we started the experiment—and we were able to say that we had lifted it !

Ex-Squadron-Leader W. F. REID: I wonder whether I might say a few words from the flying angle. The pilots did not like to see a great mass of flame anywhere near an aircraft. They thought that it would flash back and catch the aeroplane, and it was rather hard to sell it to them at the start. At our particular station we tried an experiment one night with fog 1,500 feet deep. We called in a pilot from another station to land after we lit up, and he came right through and made a perfect landing. That convinced us at our station. The lads did a trip on it in clear weather a couple of nights later, and then, a few weeks after that, they came in by Fido to do their landing, 16 of them, after a long night operation of something like eight hours. Every landing was perfect. They did not make such good landings in normal conditions by daylight.

There is one incident about which I would like to tell you. It happened on a rather foggy afternoon. The fog kept clearing and then coming back again. We sent an aircraft off to drop a fellow who was going on leave, I believe. There was, of course, a navigational exercise in between. Then he had to come back to land at an aerodrome quite close to our station. The Control Officer was not going to take him in. He said: " There is only about 300 yards visibility on the deck here. You go off." He telephoned Group, and there were orders to light up. By then ten minutes had elapsed. We realised that the

aircraft had only about three-quarters of an hour's petrol left, so that it was go or bust. Everybody got down to it and got the works cracking. The thing was barely alight when in came an Oxford. We were all rather surprised, but the pilot of this aircraft seemed to know just where to go. He came round the field and finally pulled up at the hangar. We were busy getting in the Lancaster. He came in without any trouble at all. Suddenly a very wild-eyed pilot came into the Control Room and said: " Thank God! How the devil did you know that I was there?" I said: " We did not." I had plenty of free beer that evening.

I would like to thank Mr. Hartley for the speed with which he got things done. He did mention earlier that they used coils for a little experiment which was not too successful. I am afraid that I was very rude about the coils. I sent in my report at 7 o'clock in the morning: " Coils an absolute flop," and I felt that way. Mr. Hartley was having the coils removed by half-past nine on the same morning. Thank you very much, Sir, for everything that you did for us.

Mr. E. J. STURGESS: Probably Mr. Hartley has some idea of how much petrol would have to be burnt to land aircraft under peace-time conditions and with modern equipment. I think that we would all be very interested if he would give us an indication of the quantity involved.

Mr. A. C. HARTLEY: It is a very difficult question. It is, I think, purely a matter of organisation, and trying to get a proper appreciation of what may be needed for the conditions at the time you are going to light up; are they stagnant conditions or are they drift conditions? Then you should use only the actual burners which are essential, and not the whole installation full out. In war-time it was different. As several speakers have said, the great thing then was to give the air crews the maximum help, and they were tremendously helped by seeing all that light to welcome them home. Squadron-Leader Reid has told us they were often returning from an eight-hour trip and were tired out. No Station Commander would save petrol by turning down burners at the risk of reducing the help given to his crews by two full-out flare-path lines alhough one of the two was completely unnecessary for fog clearance under the usual drift conditions.

Taking the normal war-time airfield such as I showed on the film, there might be 4,000 yards of burners and flat out they would use 20 gallons of petrol per yard per hour, of about 1,350 gallons a minute. On many occasions 18 aircraft have been landed in a little more than half-an-hour. If we allow two minutes per aircraft, it means we should use about 2,700 gallons for each landing. Even if we paid two shillings a gallon, that is only £270. That is for a normal war-time Fido under the most extravagant conditions.

Now for peace-time. I have explained that the larger airfields with wider runways like the rescue airfields at Woodbridge or Manston need more than 20 gallons per yard per hour to enable the heat columns to pull together in stagnant conditions and effect the initial clearance. On the other hand, as I have shown in my film, this clearance will persist for long periods—in the case illustrated for more than three-quarters of an hour—after Fido is turned off, because the vertical column of heated and cleared air descends quietly down again and keeps the surrounding fog from intruding. Under side drift conditions wider airfields do not need more heat output than the normal. In peace-time also you have a very experienced pilot landing an aircraft. He will probably have had his spare pilot in control until somewhere near home, and will arrive perfectly fresh and on the top line to use every form of instrumental aid. He will be satisfied with clearance over the runway to a low height. The normal airfield lighting on such an airfield as Heathrow is absolutely wonderful and only needs the fog cleared to make it effective. Fido can therefore be used for its job of actually clearing fog, and need not be used as an extremely extravagant flare-path.

On the other hand, civil aircraft will probably not arrive at an airfield in a bunch one every two minutes. The latest burners, however, were proved capable of being

idled for indefinite periods at very low consumption and of being instantly turned up to give any required heat output. Further, it was proved that automatic selection and ignition of the burners actually required to meet the conditions prevailing was possible by press buttons in the control room on a mimic diagram of the airfield.

To what figure petrol consumption per aircraft could be reduced in practice with these improvements, I just do not know, but I believe it could be well below the war-time figure. Mind you, there are other factors such as maintenance and operation, but here again the latest burners showed great improvements. The number of aircraft landed during the war proved Fido successful and justified the expense.

The problem really has to be weighed up as a whole again for peace and I am afraid I cannot be more definite or explicit than this.

Captain J. H. TANTON: There is one factor. £270 was the approximate cost, but not one aeroplane in, say, ten thousand, lands in fog. If the cost is divided between the number of aeroplanes, it costs each aeroplane a very small amount, which is in the nature of an insurance.

Mr. E. G. WALKER: The author has given us at the end of the paper some of the story of the part that Fido played in the final military defeat of Germany in the Ardennes. I wish to add a quotation from a report which completes the story. This is the extract: " When Runstedt opened his offensive in December across the Ardennes, the weather once again went against us. The bomber airfields of England, during that vital Christmas week, were enveloped in fog, which by Christmas Eve had spread over a wide area. The position was serious. The Germans were throwing everything into this battle in an effort to turn the Allied line. The great weight of Bomber Command was needed to smash his supply centres and cripple the transport routes leading to the Ardennes. Fog lay over a great part of the country, and was worse at the airfields of the bomber leaders, the Pathfinder Force in the East Midlands. They were urgently needed to guide the bombers of the main force on to the targets in the battle area. Yet the Pathfinders took off. Fog, only a short while ago the greatest menace to an aircraft, could be eliminated from the aerodrome runway and a safe landing made in the worst possible conditions. This revolutionary change in the air war was made possible by Fido."

That is an unsolicited testimonial for Fido. It is the report of Bomber Command, and it shows what they thought of Fido under the very critical conditions of that foggy weather. The conclusion is that the miltary economy of Fido cannot be measured only by the number of aircraft brought in or even by the number of airmen's lives saved. There were very many conditions where the introduction of Fido enabled our aircraft to take off when they could not have done so otherwise. Operations which without Fido could not have been contemplated, were possible. We cannot estimate the value of Fido by any yard stick of petrol consumption.

That brings me to another point. The whole question of the economics of Fido as applied to civil aviation has not, in my opinion been thoroughly examined at all. The only direction in which people look is the wrong direction. If you are looking at and studying the economics of a manufacturing proposition, you take out the labour cost, the cost of materials and the overhead costs. You work out that the product will cost you so much per ton or so much per article and you have a concrete figure. But the economics of Fido are different. The proposition is not that of calculating the cost of fuel to land one aircraft. Civil aircraft are to be run as transport, mainly for civilian use, in which safety is the principal factor. We do not consider the question of scrapping the whole of the very expensive signalling system of our railways because it costs money to keep it going, and yet that is the proposition which is put up in respect of Fido on civil airfields. It is incorrect. The only way in which to look upon the cost of Fido under commercial conditions is as an insurance. As one speaker here has remarked, if the cost is spread over the whole of the aircraft using the airfield it is negligible. In any case, the cost of constructing large civil airfields is very great. As we have proved, Fido is not a cheap installation, but as a percentage of the total cost of the airfield it is small. The idea that

it costs so many hundreds of pounds or so many tons of petrol to land one aircraft must be got rid of completely.

THE CHAIRMAN: Dr. Rosin, the distinguished German scientist who helped us in this work, is here. He was a refugee from the Nazis. I think that we might have a word from him.

Dr. P. O. ROSIN, F.INST.F., M.I.CHEM.E., M.I.GAS.E.: I have very little to add to what Mr. Hartley has said. I was just one member of the team, but perhaps I may be allowed for a moment to-night to speak for the whole team in expressing our thanks to Mr. Lloyd and to Mr. Hartley for their leadership. It is a debt which I feel it has never been possible to pay in public.

These were exciting times for all of us. Sometimes they were difficult, but we were always kept going by three motives. The first was, of course, our anxiety to contribute to the war effort and to assist the pilots. The second was to have to grapple with a fascinating scientific and technical problem. The third was our hope that the work would be useful for peace-time. The saddest moment for all of us was when this work was stopped, because we all felt, and we still feel, that, with the development of remote control which would have enabled us to light up just that part of the line which was necessary and to turn it all down in the minimum time, the cost of Fido would be much reduced so as to make it an economical proposition in peace-time. Moreover, I feel from the many talks that I had with the pilots and station commanders, that the combination of Radar and Fido might considerably reduce still further the quantity of petrol required, because it is possible to bring the aircraft right on to the airfield and down to a low height over the runway by Radar. The high petrol consumption was needed because the clearance had to be 100 feet. If one can guide an aeroplane by Radar much further down, much less clearance is required and much less petrol consumed.

An appeal has been made to the Minister to reconsider Fido. All that I want to say is that from this gathering to-night it seems as if the team is still there and so is the knowledge and the enthusiasm.

Major CADMAN, M.B.E.: I am sure that you would wish a vote of thanks to be accorded to our Chairman for the admirable way in which he has conducted this meeting. I am not going to keep you long, because Sir Harold Hartley has already mentioned the points to which I was going to refer, namely, the great value of the team work of which Mr. Lloyd was the inspiring leader. He was the ideal team leader, and I am quite sure that he will be again if his services are required.

The vote of thanks was carried with acclamation and the meeting then terminated.

[*Note.*—In the debate on Civil Aviation in the House of Lords, on the 26th November (Hansard, Vol. 144, No. 6) Viscount Swinton asked:

> "What is being done to instal blind landing equipment? When will it be completed and, if it cannot be completed for a considerable time, why was Fido discontinued at Heathrow?"

Lord Nathan, in reply, explained that the aids at present available for landing in poor visibility, and in course of installation at Heath Row, were for blind approach and not completely blind landing, the last stages of landing being still completed by sight. Systems enabling completely blind landings to be made were under development, but this work would not be successfully completed for a very long time to come. He continued:

> "At any time there will always be the psychological preference for visual rather than instrument landings. I have therefore set on foot a re-examination

of the potentialities of Fido to ascertain whether, in the present state of development of radio aids, a useful purpose may still be served by the installation of Fido. I am also having enquiries made in the United States to ascertain what is the practice now in that country".]

THE FRONTIER AREAS OF BURMA

by Brigadier J. F. BOWERMAN, C.B.E., *late Inspector-General, Burma Frontier Force*

India and Burma Section, Thursday, November 7th, 1946

Colonel the Right Hon. Sir REGINALD DORMAN-SMITH, G.B.E., *late Governor of Burma, in the Chair*

THE CHAIRMAN: To-day it is to be our privilege to hear about the Frontier Areas of Burma from a distinguished officer who is in every way qualified to speak on this important subject. Brigadier Bowerman served for some 15 years in the Frontier Districts both in the Military Police and in the Burma Frontier Force; but he did more than merely serve his time there—he took a lively interest in the peoples among whom he was serving, and also took the trouble to learn five different Frontier languages. One cannot do that without learning a lot about the ways, customs, hopes and needs of the ordinary men and women who speak those languages.

The lecturer knew the Frontier Areas well before the War; he saw them during the War, and returned to them while the Japanese were being forced out of Burma. He knows their strength and their weaknesses; he knows too the effect which the War has had on their general outlook. Moreover, his education was completed when he was called upon to act as Chief Liaison Officer between the Imperial troops and the Chinese Allies in Burma during the 1942 campaign, which was no easy assignment. Burma's Chinese neighbours are of first-class importance to her, and will perhaps come even more into the Burma news once Burma proper becomes a fully self-governing country.

The fate of the hill peoples of Burma must be a matter of grave concern to us. Among them we found the stoutest possible allies in our time of greatest need. The pity is that so few of us know much about them. To an ordinary British audience the names Chins, Kachins, Karens, Shans or Was mean little. Yet it is true to say that at this moment these peoples are relying upon us to see to it that whatever else may happen in Burma, they get a square deal.

We look forward to-day to learning more of these fine people from Brigadier Bowerman, upon whom I now call to address us.

Brigadier BOWERMAN then read the following paper:

In October, 1945, at the time of the return of the Civil Government to Burma, a message to the people from His Majesty the King was given wide circulation throughout the country. This message contained the following special reference to the hill people of Burma:

"To the hill peoples of Burma who have with such steadfast courage maintained for three long years the fight against the enemy, I wish to say a special word. Separate arrangements will be made for your administration, so that special care and attention may be given to your welfare and your indigenous institutions may be developed. I hope that the day is not far distant when you too will desire of your own free will to take your place in a self-governing Burma; and my Government

will do all in its power to forward this last step in the historic task of the unification of Burma".

In accordance with the promise conveyed in this message a separate administration has been set up for the Frontier Areas. These areas consist of the Arakan Hill Tracts, Chin, Naga and Kachin Hills, the Shan and Wa States, Karenni with additional Karen country in the Toungoo Hills and on the Salween.

The area involved is slightly less than half of Burma and about twice the size of England; the area of the Shan States (numbering thirty-two, of which Kengtung, the largest, is 12,000 sq. miles, and Kyong, the smallest, 24 sq. miles) is almost exactly half that of the whole Frontier Areas. The country consists of a mass of jungle-covered mountains in the north, opening up to delightful rolling downs and well-watered fertile valleys in the Shan States. There is no direct outlet to the sea; the districts form a horseshoe around Central and Upper Burma and act as a buffer between Burma and the countries of India, Tibet, China, Indo-China and Siam.

The population of the Frontier Areas totals approximately two and a-half millions and the people vary as much as the country. The Chins are sturdy, hard working and intelligent, but rather morose and difficult to get to know; before the war they were heavily enlisted by five units of the Burma Defence Force and made reasonably good soldiers. Their next-door neighbours, the Nagas, live in country which is more difficult of approach; they are an exceedingly primitive race and still indulge in head hunting and occasional human sacrifice. The Kachins, who gained a great reputation during the war, are a happy-go-lucky, hard-drinking and friendly people with a taste for travel and adventure. Before the war, like the Chins, they furnished a high proportion of recruits for the Burma armed forces, despite the fact that malaria and venereal disease had seriously affected the vitality of the race.

Shans are dotted about in the valleys throughout northern Burma as well as in their homeland the Shan States. They are pleasant, lethargic, rather timid folk, who invariably take the line of least resistance when any trouble is involved. Apart from the Shans, the population of the Shan States includes a variety of hill races; the Palaungs and Taungthus are Buddhists like the Shans; the Kachins, Lahus, Was and Ekaws have nothing in common with the Buddhists. In addition to these hill tribes, there are the Inthas and Danus in the Southern Shan States bordering on Burma, whose language is more akin to Burmese than Shan.

The Karen section has a number of different tribes who are less advanced than the Karens of the plains and delta—still debarred from sharing in a separate administration. The Padaungs—famous for their giraffe-necked women—are probably the toughest of these, and like others of their race in the Salween district were a thorn in the side of the Japs during the closing stages of the campaign in Burma.

Before the war, communications, except in the Shan States, were very backward. The Chin and Naga Hills were reached by mule paths leading from the Chindwin River, on which regular steamer services functioned. Myitkyina, the northern terminus of the Burma Railway, and Bhamo on the Irrawaddy, were the jumping-off places for the Kachin Hills. In the Shan States there was a good network of motor roads, including the Burma Road to China and a fair-weather track to Siam; the railway also went to Lashio in the north and within a few miles of Taunggyi in

the south. Industry, except in the Shan States and Karenni, was almost exclusively confined to a struggle for existence, in which the women did much more than their fair share of work. In many parts of the Chin and Kachin Hills there were frequent periods when stocks of rice—the staple food—dwindled to vanishing point and villagers were compelled to scour the country-side for edible roots and other substitutes. For this reason, the Chins and Kachins were able to function efficiently in operations against the Japs under conditions which would have been impossible to other races.

In the Shan States, big business was represented by the Burma Corporation, which employed over ten thousand in the extraction of a pre-war annual total of half a million tons of lead, zinc and silver from the mines at Namtu and Bawdwin. Most of these employees were Indians, as labour was unprocurable in Burma and, of course, much of the money they earned went out of the country. On the other hand the Corporation paid out large royalties to the Shan States Federation Funds and the railway carried a great deal of freight to and from the mines.

The production of tung oil for paints and varnishes was another industry which was just beginning to find its feet when the war intervened. Four European firms had opened up plantations, while chiefs and local people had been encouraged to plant trees with the prospect of selling the fruit to companies which had installed machinery for extracting the oil. Other products which had steadily increased between the wars and were exported in large quantities to Burma were potatoes, totalling 50,000 tons in 1932 compared with 5,000 tons in 1912, tea, oranges and wheat, which had jumped from 8 tons in 1912 to 3,000 tons twenty years later. The profits on these were shared between the cultivators and brokers, who were mainly Indians and Chinese. Teak, too, was worked in different parts of the Shan States and provided employment for numbers of local people as well as royalties which were shared by the federation and the chiefs concerned.

Karenni had its share of large-scale industry with the Mawchi Mines employing between 3,000 and 4,000 in working wolfram and tin concentrates, but for the same reason as the Burma Corporation, most of the employees came from India.

Before the war, the Frontier Areas, then known as the Scheduled Areas, had an administration separate from Burma conducted on the principle of indirect rule. In the Shan States this was carried out through the chiefs and in the tribal areas through forms of government which varied locally. Most of the Shan States were joined together in a federation which had its own revenues and was self-supporting financially; the other scheduled areas could not have functioned without help from the revenues of Burma.

Throughout these areas the general administration was supervised almost exclusively by officers of the Burma Frontier Service, recruited specially for duty there. The Shan States recruited officers direct for federation services, such as public works and education. In other tribal areas officers for different departments were posted by the Government of Burma, and it is worthy of note that few of these were Burmese, the chief reason being that the hill areas were unpopular among the Burmese, partly because of their remoteness and also because there was a certain amount of mutual dislike between the hill people and those of the plains. Certain of the larger states also had their own schools and hospitals paid from state funds.

Outside the Shan States hospitals were few and far between. They were poorly equipped and usually staffed by Indians.

Education outside the Shan States was largely carried out by missions subsidised by Government. Those represented were the American Baptists, the Roman Catholics, made up largely of Italian and Irish priests and nuns, and a smaller British Mission, which had arrived much later on the scene than the other two. The study of Burmese was not encouraged in certain parts of the hills, this being part of a policy designed to keep the hill people away from the unhealthy low-lying areas in Burma, where infantile mortality was extremely high. The two large missions had made many converts among the Animists in the hills, but scarcely any among the Buddhist races, who looked on them with some dislike and misgiving. It is hardly necessary to mention that the work of these missions tended to widen the gulf which separated the hill people from the Burmese, Shans and other Buddhists.

The Burma Frontier Force of six battalions, at one time consisting almost entirely of Indians and Gurkhas, but steadily changing over to indigenous races, was responsible for watch and ward on the frontier. This force as well as the Burma Army was doing a great deal to improve the standard of living and education among the classes it enlisted.

Prior to 1941, there was little political feeling in the hills—a section of the Southern Chins had voiced a desire to join the Burma Legislature and in Mongpai State the Padaungs—who were in the majority—had refused to acknowledge the authority of the Shan Chief; elsewhere the people seemed perfectly content with the varying forms of easy-going administration.

The outbreak of war in Europe made very little difference to the ordinary people in the hills: many of them did not even know the war was on and the vast majority of those who did had only the vaguest idea of its cause. Recruitment for the Burma Defence Force was stepped up to a limited extent and the Frontier Areas met the additional calls for men without much trouble. In the Shan States some of the chiefs made handsome donations to war funds and the federation unanimously decided to raise and pay for two territorial units, which were recruited within the States and officered by relatives and nominees of the chiefs.

The war between China and Japan had now come nearer Burma, resulting in greatly increased convoys of motors moving over the Burma Road to Chungking and the establishment of large dumps around Lashio. This brought added revenues to the federal funds and saw Lashio develop suddenly from an insignificant village to the most important town in Burma outside Rangoon.

The collapse of France and Japanese entry into Indo-China was the first indication of a threat to Burma; and as time went on and Japanese propaganda became increasingly hostile it seemed that a Jap invasion through Siam and the Shan States was a distinct possibility. Troops were moved from India and Burma into the Shan States, and this brought added wealth to the people, who were also reassured by their presence.

The Japanese entry into the war and invasion of South Burma was followed by a redistribution of troops; all British forces, with the exception of a few Frontier Force detachments and the partially-trained Shan territorials, were moved down to Burma and replaced by Chinese troops placed at the disposal of the British by

Generalissimo Chiang-Kai-Shek. Most of these troops came down the Burma Road through Lashio, the 5th Chinese Army—China's crack corps—going to the area between Mandalay and Rangoon, the 6th Army taking over the Shan States and covering numerous roads and tracks leading to Siam. These Chinese troops were desperately short of modern arms and equipment and were not nearly as well clothed or trained as the units they had replaced. Few of them had ever been outside China before and most of them looked and felt complete and utter strangers in a strange land. People in the localities in which they were stationed began to realise that the British were not as strong as they had imagined and an uneasy atmosphere of expectancy became apparent.

The stay of the Chinese was not protracted; by the time the last formation had taken up its dispositions the situation in Lower Burma had deteriorated to an alarming extent and Rangoon had been evacuated. This had a depressing effect on civilians as well as on the Chinese troops, who had come in full of enthusiasm. By the first week in April Chinese troops 160 miles north of Rangoon had been forced to withdraw and a motorised column of Japs made its way into Karenni through Mawchi. This column quickly smashed a way through the Chinese 6th Army, and within a month had swept through the Shan States to Myitkyina, 700 miles away, meeting with no opposition at all from the territorials or Frontier Force, who melted away at the approach of the enemy. The shattered Chinese 6th Army made its way back to China through Kentung, living on the country in its progress. The 5th Army in Central Burma found itself cut off from the Burma Road and was forced to make its way through the Kachin and Naga country to the north. One of the divisions marched to China over the mountainous country east of Fort Hertz; the remainder made their way out to Assam. All these troops were compelled to requisition and seize food in the villages through which they passed; many of them died of cholera, typhus and starvation on the way; they left a trail of desolation and death along the routes they were forced to take.

The main line of retreat of the British forces was by way of the Chindwin River through the fringe of the Chin Hills to Manipur; scattered remnants also went out to India by way of the Hukawng Valley and other more difficult passes through the mountains. In addition to the forces, thousands of refugees made their painful way towards India, leaving hundreds of dead and dying along the tracks. The hill people were badly shaken by the melancholy sight of the defeated British forces and the wretched plight of the refugees, but did their best to assist whenever called upon to do so, despite the fact that cholera laid many of them low.

Most of the eight regular units of the Burma Army were broken up in Burma, the men being given leave and allowed to return to their homes. These men later formed a useful nucleus when levies and irregulars were raised. The only unit to remain in action in the country was the Chin Hills Battalion of the Burma Frontier Force consisting largely of Chins; this battalion did excellent work for over two years under most trying conditions.

The Japanese received no welcome in any part of the Frontier Areas, but the people were stunned by the rapidity with which the deep-rooted British administration had been swept away. In the lower levels the Shans apathetically did what they were told; in the hills the people were left more or less undisturbed in the

initial stages of the Jap occupation, and stragglers continued to make their way out to India by the tracks which remained open.

At the end of the monsoon in 1942 plans began to take shape to continue the struggle inside Burma. British officers moved into the hills to raise levies, and despite the crushing defeat so recently suffered, received a hearty welcome from Chins and Kachins who were eager to join the forces. At the commencement of operations, these levies began to function in a tentative way, as Jap troops were held in considerable respect. Success, however, made the hill people more confident. They developed a complete disregard for danger and were prepared to go anywhere in their raids on Jap lines of communication. In these operations women and small boys took an active part in carrying supplies for their menfolk; cultivation was left to those who were unfit to march and fight.

In addition to the activities of the levies, agents with wireless sets worked their way down through the hills into vantage points within Jap-occupied territory and were able to send out information which was frequently followed up by rapid and accurate air action.

The Japanese soon became aware of these different activities in the hills and took action to minimise their effects. Threats were issued through Burmese officials of penalties which would be inflicted on those who helped or sympathised with the British. Arrests were made and punishments awarded by Burmese and Shan headmen and police; intelligence agents and spies were appointed by the Japs, guides were made to lead Japanese military police and other troops sent on small punitive missions. In addition to all this, heavy calls were made on local people for cattle and labour, while Burmese National Army detachments were also formed and moved about the country-side. Although much of the Burmese effort was made under duress, the apparent readiness with which Burmese officials carried out orders from the Japanese made the hill people imagine that they were enthusiastically co-operating with the enemy. The result was a deepening of the dislike and mistrust which had always existed, and a feeling that the Burmese and Shans had now taken sides as active enemies of the hill people.

In the Shan States the situation was somewhat different. Large numbers of Jap troops were stationed in different localities, and airfields abandoned by the British were in certain instances enlarged and improved. The Burma Corporation and Mawchi Mines, which had been partially wrecked before the evacuation, were put into a semblance of order; on the other hand, tung was completely neglected and plantations suffered from fires, while one was cleared for the construction of a new airfield.

The administration in the Shan States was first of all carried out by a Japanese Military Governor. Chiefs were called upon to carry out his orders and were powerless to disobey. Later the States, with the exception of Kengtung and Mongpan—which were handed over to Siam—were incorporated into Burma and a former senior Burmese officer, of the Burma Civil Service, was appointed Commissioner. The chiefs were not unduly interfered with under the new regime, but an iron hand was always in evidence to seize any who disobeyed the various Japanese security orders or who expressed any sentiments in favour of the British.

The Japanese opened up schools in parts of the Shan States with teachers brought

from Japan. They imported some rather inferior stallions to improve the breed of ponies, and took an active interest in agriculture. Students were selected for different university courses and sent off to Japan. Roads, however, were badly neglected and the few hospitals that remained open were very short of drugs and medicines.

The Shan States gradually began to suffer from heavy requisitioning made by the Japanese—all of which was done through the Burmese officials appointed by the Ba Maw Government. Large quantities of rice were demanded, cattle were taken over for food and transport purposes, cars, lorries and carts were seized, labourers were called for and forcibly transferred to Upper Burma. The loss of foodstuffs created difficulties, but these were not as serious as the loss of transport animals and vehicles. Growers of tea, potatoes and fruit who were dependent on a market in Burma now found themselves unable to move their produce and were forced to cut down production drastically; they were also unable to get up rice from Burma and many of them found themselves without food of any description. Protests made by chiefs to the officials enforcing these seizures were disregarded and the Burmese administration was looked upon with no great favour. Kengtung, the largest of the Shan States, which had been handed over to Siam, found the large numbers of Siamese troops stationed in the State a similar drain on its resources.

In 1944, when the Japanese invasion of India had been smashed at Imphal and British, American and Chinese forces began to force their way into Northern Burma, the Japanese attitude towards the Burmese and Shans underwent a considerable change. Previously the behaviour of the troops had been reasonably good, but in retreat the Japs looted and destroyed in all directions and men, women and children who had previously lived unharmed were killed without the slightest provocation. To add to the misfortunes inflicted by the Japs the Allied Air Forces, which throughout 1942 and 1943 had steadily increased their offensive, now rained destruction on roads, railways and any targets which might be of use to the enemy. Cultivation became impossible in many areas and villagers were driven from their homes to seek shelter in the jungles.

During these operations large forces of irregulars were recruited from the hillmen by both British and American organisations. One of these, the American Detachment 101, had 10,000 men on its books, the majority of whom were Kachins. These irregulars moved ahead of and on the flanks of the main forces, frequently living on a country already stripped of most of its supplies. Many of these hillmen who had suffered directly or indirectly during the Burmese administration now seized the opportunity for revenge on perfectly innocent Shan and Burmese villages on the lower levels. In a number of localities Kachins set up committees which collected tribute from neighbouring Shans; there were cases where Shan and Palaung headmen signed documents witnessed by officers of irregular forces saying that they voluntarily placed themselves under Kachin protection. In the Shan State of North Hsenwi the Kachins induced the Sawbwa to sign a paper saying that he and his heirs gave up all claim to authority over the Kachins: in adjoining States the Kachins merely informed the chiefs that they were no longer recognised. In the south, the Mongpai chief fled from his State in fear of the Karens, in South Hsenwi the Sawbwa was thoroughly alarmed by threatening

letters from the Kachins. The Wa States were in a state of turmoil with rival factions and races milling about shooting one another.

While all these disputes were going on between people living inside the frontier of Burma, parties of Chinese added to the general state of unrest. Detachments of so-called irregulars made their appearance at different points along the frontier, some with the pretext of fighting the Japs, others bent on taking over tracts of country, still more in the south-east corner of the Shan States who made large levies of opium on the villagers. In accordance with usual custom all of these visitors demanded food and accommodation wherever they appeared. The Chinese Army in Burma had nothing to do with these intruders, but it was impossible to take adequate steps to eject them from localities near the regulars as this might have brought about serious trouble. There were also deserters from Chinese formations who lay low until their parent units moved on, then formed themselves into bands which robbed and blackmailed the inoffensive people. When the Chinese armies from Burma moved back to China, armed police units were raised from disbanded irregulars and these very quickly dealt effectively with administrators and deserters alike and sent them hurrying back to China.

The tasks of feeding the destitute, restoring communications, opening up schools and hospitals and the restoration of law and order fell upon Civil Affairs Officers attached to the various British and American formations. Supplies, staff and equipment were hopelessly inadequate, but everything possible was done with the extremely limited resources at the disposal of these officers. The Civil Affairs staff was settling down and beginning to find its feet when the Civil Government of Burma returned to take over the administration of the country. The Civil Government found itself faced with the same problems as the Civil Affairs staff, with the added difficulty that it was not a part of the army but yet was entirely dependant on the Forces for a variety of services; many of the senior officers of the Civil Government were also handicapped by having no first-hand knowledge of conditions in the country.

Conditions in many parts of the Frontier Areas had undergone a great change during the war. In the Chin, Naga and Kachin Hills, motor highways like the Imphal and Ledo Roads had been constructed through almost virgin jungle. Streams of motor vehicles, all types of modern road-making equipment, and thousands of troops, both mechanized and infantry, had poured through the hills. First-class airfields and large military installations had been constructed. Hill people who before the war had never seen a bicycle, now expected to travel by motor or even aeroplane, and money had been distributed lavishly among those who had rendered any services or who had local supplies to sell. The departure of the troops and disbanding of the various forces of irregulars meant a reversion to pre-war conditions of life which many were loth to accept.

The meagre trickle of supplies which now came into the hills, the lack of hospitals and schools, caused bitter disappointment among those who had suffered in the early stages of the Japanese occupation. In different localities committees of elders had been set up. These voiced the grievances of the people, which included many accusations of oppression and collaboration with the enemy against the Burmese and Shans. Counter-accusations were made by Shans and Burmese of looting,

robbery and murder. It was plain to see that the war had created bitter feeling between the different races; and it would require time, patience and tolerance to bridge the gulf between them.

All races in the Frontier Areas demanded a separate administration from Burma directly under the British. The Kachins in the Shan Staties wanted their tracts attached to the Kachin Hills further north ; those over the Chinese border had a faint hope that they too might join this confederation. The Shan chiefs were reluctant to give up Kachin or Karen tracts and a number suggested that the smaller states should be amalgamated so that public services in these States could be improved. The Karens of Karenni and Mongpai, together with leaders from the Toungoo Hills, claimed the whole of Central Burma, east of the Sittang River, as well as Tenasserim for the Karens. Delta Karens who had suffered much during the Japanese occupation, also demanded that parts of the Delta should be separated from the administration of Burma.

The publication of the King's message and setting up of the Frontier Areas Administration did much to ease the tension, but certain sections were still not satisfied. Kachins in the Shan States, although promised representation on the chief's advisory councils, still wanted to be cut adrift from the Shan States. Shan chiefs disliked the association with the other hill races and felt that revenue from the States would be diverted to other poorer sections which in pre-war days had borrowed from the revenues of Burma. The Plains Karens have shown their feelings by sending a deputation to Britain to put their case for separation before the Government.

The Burmese have shown some interest in these areas since the new administration has been set up; U Saw, the Premier of Burma at the time of Japan's entry into the war, visited the Shan States earlier this year in an endeavour to establish better relations with the chiefs.

One of the principal problems confronting the new administration is that of finance. Before the war the only section that was self-supporting was the Shan States, but the collapse of some of the main industries in these States has greatly diminished the revenue. The Burma Corporation cannot get labour unless the Burma Government will admit the necessary number of Indians. The destruction of the Gokteik Viaduct on the Burma Railway between Lashio and Maymyo prevents the bringing in of heavy equipment and the sending out of large quantities of metal. The Mawchi Mines in Karenni are faced with the same labour difficulties, but have not the same problems over communications. The heavy damage to tung plantations will take years to adjust and it will be a long time before the production of potatoes, tea and fruit reaches its pre-war level.

The British Treasury is financing the Frontier Areas at the present time in the same way as it is financing Burma. Whether it will continue to do so indefinitely if these areas refuse to join hands with Burma, time alone will show.

The geographical position of the Frontier Areas with no outlet to the sea, except through Burma or Siam, is a major difficulty in a separate administration. The unification of Burma would solve many difficulties; to bring this about it will be necessary for Burmese and hill races to forget much of the past and to show a tolerance towards one another which up to now has been conspicuous by its absence.

DISCUSSION

Sir HTOON AUNG GYAW (Ex-Minister of Finance and Revenue, Burma): The Burmese point of view is very simple. We are in perfect sympathy with the hill tribes, and the people realise that we are a Thibetan race. I had the pleasure with Sir Reginald last February of visiting the Kachins and mixing with them, and I thought they were part of my own people. Looking at their views and customs, I felt that my forefathers must have come from the same stock.

As for the Chins, they were in the hills before the Burmese came; while the Shans came about 700–800 years ago. They were the rulers of Upper Burma for 200 years. Then came the Burmese renaissance, and we got back Upper Burma, and have lived side by side as friends for over 300 years before the British set foot there. The Karens have probably been there much longer, before the Burmese came down from Thibet. Some people think there is antagonism between the Burmese and the Karen people, but that is far from the truth. We have lived in amity for centuries. To say that the Burman is antagonistic towards the Chins is also not true. The Chins live in the hills and the Burmese live in the valleys, and there is no quarrel between them. The Shan people live in the plateaux which the Burmese abandoned 2,000 years ago for the more fertile valleys. One of the difficulties we find to-day is to get good Burmese officers to go to hill stations.

Federation we accept, and we welcome, and further may I point out that there are much bigger differences between the Chins and the Kachins, and between the Kachins and the Shans. The hills where the Kachins live were once Shan country and there is some ill feeling between them. It seems to me it is futile to think that there is a common denominator between the Chins, the Kachins and the Shans. If there is a possibility of a common denominator, it is the Burmese with whom these hill people are bound both geographically and economically.

Burma must be united if it is to progress and if it is to have security. The defence of Burma does not begin and end at the Irrawaddy Valley or at the Mandalay foothills. The defence of Mandalay is on the Chinese border. Not merely the security of the Burmese race, but the security of all the hill tribes, emphasises that Burma should be one unit, and that we should be not merely federated but amalgamated.

That brings me to what the Burman is. Our history books 800 years ago said, "What is a true Burman?", and went on to give a list of seven races from which he sprung—the Mons, Thets, Pyus, Karens, Chins, etc. Even the Mons of the one-time superior Mon-Kemer civilisation have become part of the Burmese race. Only a few villages still speak the Mon language; all others speak Burmese. The modern Burman is a combination of six or seven different races, and is not merely Thibetan. I am quite certain that a lot of the Karens have become Burmese. It is only a question of time, goodwill and security before the Karens of the plains and the tribes of the Hills will be proud of being Burmese.

Mr. SYDNEY LOO-NEE: I should like to take this lecture in conjunction with the White Paper, where it is stated that the hill tribes have "a double claim to British consideration", and as they have not yet come to the stage where they can federate on equal terms with Burma proper, they are to have a government still under the British. It is only when that policy is clear and we know it will be acted upon that other questions can be entered into, otherwise I think we shall be only dealing in platitudes. Also it is necessary to know whether the other indigenous races of Burma are to be given self-determination or whether for the present problems will be determined for them.

We have heard from Burma that a section of the Burmese people do not want any Frontier Area to be excluded from Burma proper and want Burma to be taken as a whole. Therefore, the title of this paper being "The Frontier Areas of Burma", we can have a practical discussion on this question only if we know the ground on which we really stand. If His Majesty's Government's declaration is not to be put into practice, and if U Aung San is to have his demands, then the picture of Burma becomes different from

what it was contemplated when the White Paper was drawn up. I have given some thought to this subject, and it is not as easy as it appears at first sight. We must have frank discussions that will yield some results; but if we are only to speak on general lines, we shall go away without having achieved anything.

THE CHAIRMAN: I think those discussions which Mr. Sydney Loo-Nee has in mind will take place amongst all the tribes. Now I myself feel that I know very much more about the people with whom we are concerned. It is important that we should have this knowledge as the settlement of this particular question is going to decide whether Burma is going to be a peaceful country or not. Here to-day we have people who will take an interest in it, as well as those who can educate us and teach us what the problem really is.

Mr. MAUNG OHN said: There is far too much distinction made between the peoples of the world. Let us regard ourselves rather as human beings and not as so many nationalities or colours. We can correct views we hold by mutual discussion. We talk of self-determination and federalism. Federalism is a complex form of government, and as we are trying to master the art of government it is better to go from the simple government to the complex. In spite of our present administrative divisions, I prefer to divide the country according to Dr. Dudley Stamp's seven natural regions. Geographical and economic unity is thus obtained. I would introduce the Elder Council in each village, town and district of the sections, and elect two members from each community residing in those areas to these Councils. There should be such a Council with two members from each community to advise the Government now. Each division should estimate how many people they have and how much money they would need to raise; education should also receive assistance. There should be equitable distribution of supplies, finance and social services, and there should be regional grouping for efficient administration and planning.

Finally, I hope there will be only two Houses in Burma, one for the whole of the country and the other for nationalities with each community electing an equal number of members. The country is so small that economic unity is essential, and planning must be carried out. The Burmans must live together as one people, and not be divided into small nationalities. I feel that in Burma it is because we have this art of living that it is one of the few places on earth where we can contribute something new, where society will know how to live and how to govern itself. There is a great opportunity for us all in Burma now.

U SAW OHN TIN: I should like to say something about trade and industry. In the Shan States we have the Burma Corporation, which the lecturer said could not get labour unless the Government would permit the necessary number of Indians to enter. People in the Frontier Areas have greatly changed during the War. They have seen money and have learnt how to use it, and I should like to see their higher standard of living maintained. If we were to believe that these big mining companies cannot carry on without the help of labour from India, I feel the local people would again be left out in the cold. Before the War there were reasons why indigenous people could not get labour —because they found that Indians were actually in the labour stronghold, and they could not compete in the conditions then existing. Things have changed, and the Burmese people should be given a chance. I believe the major problems that confront Burma, either industrially or politically, cannot find any lasting solution unless and until indigenous labour is given a chance in Burma's industries.

Major W. H. CADMAN, M.B.E.: With regard to the "horseshoe" shape of the Frontier Areas, the magnificent combined Military and Air operations which had resulted in the Japanese being driven out of Burma, proved that impenetrable jungles, deserts and mountains, which were once regarded as forming a very strong natural barrier between Burma and India and the rest of Asia, could no longer be considered as obstacles against

a modern army with close co-operation from air and land forces. That fact should be taken into account in future when considering the defence of these countries.

Brigadier BOWERMAN: With regard to the question of separate administration of the Frontier Areas of Burma I am confident that there is not a single British officer who has lived in Burma and has had any contact with the people of the Frontier Areas, who does not want to see a unified Burma. The Frontier Areas are dependent on Burma for a very great deal apart from communication with the outside world; Burma depends on those areas for a large proportion of the best troops in the Burma Army and Frontier Police.

If the hope of unification expressed in His Majesty's message is to be fulfilled it seems that this can best be accomplished by the different races getting together much more and sorting out the problem for themselves rather than attempting to do it from England. I personally look forward to seeing Burma and the Frontier Areas merge together into a self-governing member of the British Commonwealth of Nations.

THE CHAIRMAN: It is my privilege to thank the speaker to-day. We have had a most interesting discussion and a most unusual one for this great City of London, inasmuch as there have been so many Burmese speakers to help us in forming our views. The only thing we can do as individuals is to approach our Members of Parliament, and the more we know about the subject the more we can help to reach the right solution.

Major CADMAN then proposed a vote of thanks to the Chairman. The vote of thanks was carried with acclamation, and the meeting then terminated.

GENERAL NOTE

JUBILEE OF THE DISCOVERY OF THE ELECTRON.—The fiftieth anniversary of the discovery of the electron by Sir Joseph Thomson, O.M., the British physicist, will occur next year. This discovery, in addition to its importance in the founding of the modern science of atomic physics, led, through the development of the thermionic valve, the cathode ray oscillograph, and other applications, to the establishment of modern telecommunications, and to the development of new instruments and means of investigation in innumerable branches of pure and applied science. To celebrate this jubilee and to illustrate the effect of such a discovery on the life of the community, the Institute of Physics and the Physical Society are jointly arranging a series of meetings and other functions to take place in London on the 25th and 26th of September, 1947. A special exhibition, illustrating the growth of the developments mentioned from their experimental beginnings, will also be held for several weeks at the Science Museum, South Kensington, and will be open to the public.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, DECEMBER 9..Fuel, Institute of, at the Institution of Mechanical Engineers, S.W.1. 6 p.m. Major Kenneth Gordon, "**Progress in the Hydrogenation of Coal and Tar.**"

Geographical Society, Royal, Exhibition Road, S.W.7. 5.30 p.m. Dr. E. C. Willatts, "**Some Geographical Factors in the Palestine Problem.**"

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C.2. 5.30 p.m. J. S. Wills, "**Goodwill in Road Passenger Transport.**"

TUESDAY, DECEMBER 10..Anthropological Institute Royal, 21 Bedford Square, W.C.1. 5.30 p.m. Tracy, Philipps, "**The European Ethnological Composition of Canada.**"

Architects, Royal Institute of British, 66 Portland Place, W.1. 6 p.m. John Summerson, "**Heavenly Mansions.**"

British Decorators, Incorporated Institute of, at the Royal Society of Arts. 6.30 p.m. E. Maxwell Fry and Jane Drew, "**The Character of Modern Interiors.**"

Chemical Society, Queen's University, **Belfast.** 8 p.m. Professor H. C. Urey, "**Isotypes.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. E. C. Cork, "**The Design and Performance of Receiving Aerials for Television.**"

Illuminating Engineering Society, at 2 Savoy Hill, W.C.2. 6 p.m. A. Cunnington, "**Railway Lighting.**"

Kinematograph Society, British, in the Neville Hall, **Newcastle-on-Tyne, 1.** A. G. Penney, "**Fluorescent Lighting.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester, 3.** 6.30 p.m. T. W. Corker, "**On Foot through the Peak.**"

Physics, Institute of, The University, **Glasgow**, Professor Oliphant, "**Betatrons.**"

Rheologists' Club, British, at the Royal Society of Arts, W.C.2. 2.30 p.m. R. L. Brown and Dr. E. W. J. Mardles, "**Dilatancy**" and "**Thixotropy.**"

University of London, King's College, W.C.2. 5.30 p.m. Maurice B. Reckitt, "**Maurice to Temple : A Century of the Social Movement in the Church of England.**" (Lecture VIII.)

At School of Slavonic and East European Studies, W.C.1. 6 p.m. F. Friedeberg Seeley, "**Pushkin.**" (Lecture VIII.)

WEDNESDAY, DECEMBER 11..**Aeronautical Society Royal**, at the Institution of Civil Engineers, Gt. George Street, S.W.1. 6 p.m. S. P. Woodley, "**Photolofting.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. R. C. Cuffe, "**Lighting Surges on Transmission Lines in Ireland.**"

Petroleum, Institute of, 26 Portland Place, W.1. 5.30 p.m. **Symposium on Oil Fires.**

Sanitary Engineers, Institution of, at Caxton Hall, S.W.1. 6 p.m. J. H. O. Bunge, "**The Thames Barrage.**"

Sanitary Institute, Royal, 90 Buckingham Palace Road, S.W.1. 2.30 p.m. Professor Harold Burrow, "**Future Control of Abattoirs and Knacker Yards.**"

University of London, School of Slavonic and East European Studies, W.C.1. 5 p.m. G. Nandris, "**Antioch Kantemir : his diplomatic mission in London.**"

At 6 p.m. Professor R. R. Betts, "**Central Europe, between 1346 and 1526.**" (Lecture VIII.)

THURSDAY, DECEMBER 12..**British Foundrymen, Institute of**, at 4 Grosvenor Gardens, S.W.1. 7 p.m. Dr. L. Northcott, "**Centrifugal Casting.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. G. E. Haefely, "**Growing Importance of Plastics in the Electrical Industry.**"

Imperial Institute, South Kensington, S.W.7. 3 p.m. L. J. D. Fernando, "**The Geology and Mineral Resources of Ceylon.**"

Photographic Society, Royal, 16 Princes' Gate, S.W.7. 7 p.m. A. Marriage and D. C. Gresham, "**Masking and its Methods.**"

Physics, Institute of, at the College of Technology, **Manchester.** 6.30 p.m. Dr. J. H. Shaxby, "**Colour and the Eye.**"

Town and Country Planning Association, 28 King Street, W.C.2. 1.15 p.m. Professor J. D. Bernal, "**Is Town Planning a Science ?**"

University of London, King's College, W.C.2. 5.30 p.m. Lord Hailey, "**Developments in Colonial Administration by European Powers.**"

FRIDAY, DECEMBER 13..**Chemical Engineering Group** at the Geological Society, W.1. 5.30 p.m. D. Allan, "**A Survey of Fat Splitting.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. R. S. J. Spilsbury and A. Felton, "**A Millisecond Chronoscope.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester, 3.** 6 p.m. Reginald S. Booth, "**Paris.**"

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. S. J. Wright, "**Mechanical Engineering and Agriculture.**"

Oil and Colour Chemists' Association, at the Engineers Club, Albert Square, **Manchester.** 2 p.m. F. Fancutt and Dr. J. C. Hudson, "**Paint Settling.**"

Sanitary Institute, Royal, 90 Buckingham Palace Road, S.W.1. 10.30 a.m. (i) Dr. S. F. Allison, "**The Welfare of Old People.**" (ii) J. E. Nicole, "**The Mental Health of the Elderly.**"

Textile Institute, 16 St. Mary's Parsonage, **Manchester, 3.** 1 p.m. W. Scholes, "**Settlement of Disputes in the Textile Industry.**"

At Technical College, **Bolton.** 7.30 p.m. Sir Raymond Streat, "**Looking Forward.**"

SATURDAY, DECEMBER 14..**Kinematograph Society**, British, Film House, Wardour Street, W.1. 7.15 p.m. P. H. Bastie, "**British Influence in the Technical Development of Kinematography.**"

MONDAY, DECEMBER 16..**Photographic Society, Royal** Exhibition Road S.W.7. 8 p.m. F. Spencer-Chapman "**Travels in Japanese-Occupied Malaya.**"

TUESDAY, DECEMBER 17..**Dyers and Colourists, Society of**, at Field's Cafe, **Huddersfield.** 7.30 p.m. A. Klinger, "**A Survey of Continental Finishing.**"

East India Association, at the Caxton Hall, Caxton Street, S.W.1. 2.30 p.m. Sir William Stampe, "**East and West in Cooperative Action : A Himalayan Dream.**"

Eugenics Society, at the Royal Society, W.1. 5.30 p.m. J. W. B. Douglas, "**Social and Economic Problems of Childbearing in Britain.**"

Hull Chemical and Engineering Society, Church Institute, Albion Street, **Hull.** 7.30 p.m. F. R. Bradbury, "**Field Trials with Insecticides in India.**"

Industrial Transport Association, at the Royal Society of Arts, W.C.2. 6.30 p.m. Harold Elliott, "**Road Operative Services.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester, 3.** 6.30 p.m. J. Alan Haddy, "**Sierra Leone.**"

Physics, Institute of, at the Polytechnic, Regent Street, W.1. 5.30 p.m. Professor W. V. Hayneord, "**Applications of Nuclear Physics in Medicine.**"

WEDNESDAY, DECEMBER 18..**Chemical Society**, at the Royal Institution, W.1. 7.30 p.m. Professor Harold C. Urey, "**Some Problems in the Separation of Isotopes.**"

Industrial Transport Association, at Chamber of Commerce, New Street, **Birmingham.** 6.45 p.m. R. H. Wilson, "**Traffic Operation at Lawley St. (L.M.S.R.).**"

Kinematograph Society, British, Film House, Wardour Street, W.1. 7.15 p.m. A. Cavalcanti, "**The Work of the Director.**"

Mechanical Engineers, Institution of, at Merchant Venturers' Technical College, **Bristol.** 7 p.m. Dr. H. J. Gough, "**Research and Development Applied to Bomb Disposal.**"

Radio Engineers, British Institution of, at the London School of Hygiene, W.C.1. 6 p.m. P. Vigoureux, "**Quartz Oscillators.**"

THURSDAY, DECEMBER 19..**Aeronautical Society, Royal** at the Institution of Civil Engineers, Gt. George Street, S.W.1. 6 p.m. J. Smith, "**The Evolution of the Spitfire.**"

Chemical Society, at the University, Edinburgh. 5.30 p.m. Professor Harold C. Urey, "**Some Problems in the Separation of Isotopes.**"

Mechanical Engineers, Institution of, at the Institution of Electrical Engineers, Savoy Place, W.C.2. 5.30 p.m. C. H. Sparks, "**The Future of Pulverized Coal Firing in Great Britain.**"

At the Engineer's Club, Albert Square, **Manchester.** 6.45 p.m. F. M. Green and J. E. Wallington, "**Aircraft Propulsion.**"

The Physical Society, Colour Group, at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2. **The Report on Defective Colour Vision in Industry.** Introduction of the Report and Discussion.

FRIDAY, DECEMBER 20..**Dyers and Colourists, Society of**, Enoch Hotel, **Glasgow.** 7 p.m. John Boulton, "**The Dyeing Properties of Direct Cotton Dyes.**"

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. A. Sykes, "**Progress in Turbine Gear Manufacture in Recent Years.**"

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4733 *FRIDAY, DECEMBER 20th*, 1946 Vol. XCV

DR. MANN JUVENILE LECTURES

WEDNESDAY, JANUARY 1ST, at 2.30 p.m.—"THE CHILDREN'S HOUR". By Derek McCulloch ("Uncle Mac"), Children's Hour Director, B.B.C. (Illustrated by recordings and demonstrations).

WEDNESDAY, JANUARY 8TH, at 2.30 p.m.—"THE STORY OF GLASS". By J. H. Partridge, B.SC., PH.D., of the Research Laboratories, General Electric Co., Ltd. (Illustrated by a sound film and demonstrations).

Refreshments will be provided after both meetings.

These lectures are suitable for children of twelve and over.

A number of tickets for these lectures are still available. Fellows desiring tickets are advised to apply to the Secretary as soon as possible, as the issue is limited to the number which the Library can accommodate. Fellows are entitled to three tickets (admitting one adult and two children) and should state the number required and the date or dates of the lectures to which admission is desired.

LECTURES ON "ECONOMIC RECONSTRUCTION"

Of the many great problems facing this country at the present time, those probably are the most pressing and fundamental which relate to the adjustment of our national economy to the changed conditions of the post-war world. The Council have therefore decided to devote a considerable proportion of the remaining Ordinary Meetings during the present Session to consideration of various aspects of "Economic Reconstruction".

The series will be opened on WEDNESDAY, JANUARY 15TH, at 5 p.m. with a paper on "GREAT BRITAIN IN RELATION TO THE WORLD'S TRADE SITUATION" by Sir Charles Lidbury, Chief General Manager, Westminster Bank, Ltd. The Right Hon. Viscount Bennett P.C., K.C., LL.D., President of the Society, will preside.

The other papers arranged are as follows —

JANUARY 29TH.—"SCIENTIFIC APPROACH TO LABOUR PROBLEMS". By Walter C. Puckey, M.I.P.E., Director and Works Manager, Messrs. Hoover, Ltd. The Right Hon. Lord Citrine, P.C., K.B.E., will preside.

FEBRUARY 12TH.—"MATERIALS". By F. A. Freeth, O.B.E., D.SC., PH.D., F.R.S., of Imperial Chemical Industries, Ltd. The Right Hon. John Wilmot, M.P., Minister of Supply, will preside.

FEBRUARY 26TH.—"FINANCE AND THE USE OF MONEY". By A. H. Ensor, Chief General Manager of Lloyds Bank, Ltd. The Right Hon. Lord Kennett, P.C., G.B.E., D.S.O., will preside.

MARCH 12TH.—"CRAFTSMANSHIP". By Reco Capey, R.D.I. J. A. Milne, C.B.E., will preside.

APRIL 16TH.—"PRODUCTION". By the Right Hon. Oliver Lyttelton, D.S.O., M.C., M.P.

APRIL 30TH.—"DISTRIBUTION". By E. J. B. Lloyd, B.A., LL.B., Director and Secretary, Lewis's Investment Trust, Ltd. The Right Hon. Lord Woolton, P.C., C.H., will preside.

MAY 14TH.—"BRITAIN'S ECONOMIC FUTURE". By Alfred C. Bossom, F.R.I.B.A., M.P. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Society, will preside.

MEETING OF COUNCIL

A meeting of the Council was held on Monday, December 9th, 1946. Present: Viscount Bennett (in the Chair); Lord Aberconway; Sir Frank Brown; Major W. H. Cadman; Sir Edward Crowe; Mr. E. W. Goodale; Sir Thomas Holland; Sir Harry Lindsay; Mr. J. A. Milne; Mr. Keith Murray; Mr. J.W. Ramsbottom; Mr. E. M. Rich; Mr. E. Munro Runtz; Captain A. H. Ryley; Viscount Samuel; Sir Frank Smith; Mr. William Will and Miss Anna Zinkeisen; with Mr. K. W. Luckhurst (Secretary) and Mr. C. Burns (Assistant Secretary).

The following were duly elected Fellows of the Society :—

Akers, Sir Wallace Alan, C.B.E., London.
Allen, John Frank, M.A., PH.D., Cambridge.
Angrave, Angus C., London.
Barwell, Herbert Rex, M.A., B.SC., PH.D., London.
Bassett-Lowke, Wenman Joseph, Northampton.
Bidwell, Henry Thomas Wallace, London.
Bland, Gilbert M., Lancaster, Lancs.
Button, Eustace Harry, Bristol.
Chadwick, Sir James, PH.D., F.R.S., Liverpool.
Clough, Dennis Maskew, B.A., London.
Dodds, Albert Charles, Edinburgh.
Drew, Miss Jane B., London.
Duffy, William Noel, Cheadle, Cheshire.
Ervine, Mrs. Leonora Mary, Seaton, Devon.
Fitchew, Miss Evangeline Esther May, Bristol.
Frost, Miss Kathleen Margaret, Worthing, Sussex.
Haarhoff, Professor Theodore Johannes, Johannesburg, South Africa.
Hadfield, John Charles Heywood, Hitchin, Herts.
Harrison, Arthur Ganderton, Callington, Cornwall.
Harvey, Arthur Edward, A.R.C.A., Chipping Campden, Glos.
Hemming, Sam Isaac, A.R.C.A., Hull.
Horsfall, Walter Stanley, Blackpool.
Iyun, Benjamin Bankole, Greenheys, Manchester.
Jackson, Leonard Cecil, M.SC., PH.D., Bristol.
Keeley, Thomas Clews, Oxford.
Ketchum, Philip Allan Cheyne, M.A., Ontario, Canada.
King, Frank George William, Sutton Coldfield, Birmingham.

King, James Grieve, O.B.E., D.Sc., PH.D., London.
Lee, George William, M.Sc., Purley, Surrey.
Litherland, Roland Hollis, Altrincham, Cheshire.
Lockwood, Luke Vincent, New York City, U.S.A.
Mahta, Dinanath Peter, O.B.E., B.A., Bombay, India.
Manson, Thomas Beaton, B.Sc., Edinburgh.
Playle, Albert Benjamin William, London.
Purvis, Robert William, Jarrow, Co. Durham.
Robertson, Norman Charles, M.B.E., Burnham-on-Crouch, Essex.
Ryland, Miss Lilian Mabel, St. Albans, Herts.
Saul, The Rt. Rev. Charles Leslie, D.D., London.
Sharples, Robert Everard, Blackburn, Lancs.
Statham, Stephen Haywood, London.
Thornton, Henry Gerard, D.Sc., F.R.S., Wheathampstead, Herts.
Whiskin, Leonard Charles, London.
Williams, Fatayi A., B.A., Lagos, Nigeria.

The President reported correspondence with the Prime Minister on the subject of the proposed 1951 Exhibition.

It was resolved to open membership of the Society on special terms to limited liability companies.

It was reported that owing to war damage, accentuated by restoration work now in process in the Lecture Hall, the ceiling of the Library had become dangerous and had had to be pulled down, but that the room was now in usable condition once more.

A quantity of formal and financial business was transacted.

EMBROIDERY AS AN EXPRESSION OF NATIONAL CHARACTERISTICS

By Miss E. Kay Kohler, A.T.D.

Third Ordinary Meeting, Wednesday, November 20th, 1946

Mr. Ernest Thesiger *in the Chair*

The Chairman: I am never very clear about what the functions of a Chairman are on these occasions. Whenever I have given an address myself, the Chairman has been a total stranger to me and has introduced me to an audience that he had never seen before, which seems to me a rather unnecessary proceeding; but if there are any of you to whom Miss Kohler is unknown, which I can hardly believe, it is my duty to introduce her to you.

The next function of a Chairman is to say how very much he is looking forward to the paper that is going to be read. On this occasion I can be perfectly sincere about that, because anything which stimulates our interest in the wonderful art of embroidery is, I think, very important in these rather matter-of-fact drab days. The craftsman has given place to the mechanic, and the person who used to ply the needle now turns a handle; and anything that encourages individual design and individual effort is specially to be welcomed.

I think we can profit very much, even without the spoken word to which we are looking forward, by the lovely exhibition of embroideries on the walls of this room.

I will now call upon Miss Kohler to read her paper.

Miss KOHLER then read the following paper:

The characteristics observable in contemporary needlework and embroidery are not rooted in one country, but are derived from many sources, and just as one realises that contemporary architecture is derived from influences as far apart as Sweden, America, Holland, Germany and France, so one looks far afield for the influences that will produce vigorous and creative embroidery in England, where a revival is being planned.

Every designer for a craft such as embroidery needs contact with, and inspiration from, something which will give stimulus to his talent, and it has formerly been the case that the continental designer has had rich sources of supply in the traditional work of his own and nearby countries, and that the more frequent intermingling of nationalities has led to interesting developments and opportunities denied to our more insular race.

So now a large collection of 1,600 embroideries from all over the world has been formed by the Needlework Development Service and is being added to steadily, so that the young designer may see work of permanent interest because of its colour and design and varied technique, and may learn something of the romance and history of this most delicate and domestic of all the crafts—which is a fascinating study for anyone interested in needlework of other countries and other times.

VARIED APPROACHES

The approaches to the study of embroidery are so varied that the amateur, the historian, the artist, the traveller and the geographer can all find points of interest; and it is my intention to mention a few of these by-ways, so that the mind can conjure up some of the influences that have helped to vary the designs or stitchery of the specimens shown to-day.

HISTORICAL INFLUENCES

Conquests.—The historian notes the influences upon embroidery caused by conquests, such as the Norman Conquest of the Saxons, which was the inspiration of that famous roll of needlework made at Bayeux. This is a large-scale embroidery on a length of linen canvas 227 feet long and 20 inches wide; the roll depicts exciting incidents in Saxon history from the time of Edward the Confessor to the defeat of Harold by the Normans at Hastings.

The figures and animals are full of movement and character, and are worked in flat stitch and outlined with coloured wools of blue and green and brown and ochre. This embroidery is one of the liveliest examples of stitchery in the world.

Another conquest took place in the twelfth century, when Roger II, the Norman King of Northern Sicily, invaded Greece, took Corinth and Argos, and carried off to captivity in Sicily many weavers and embroiderers, who carried Greek ideas into Italy and gradually assimilated the culture of their conquerors.

The conquest of Granada in 1492 had a sweeping effect on design and embroidery, for although the Moorish rule was overthrown (and the dominion of the Moors in Spain had lasted for 782 years) yet the Moorish influences persisted for hundreds of years, while Spanish motives and design were introduced and the patterns of Upper

Italy gradually exercised more influence in Spain. Until 1609 the descendants of these capable Arabic craftsmen were still living in hundreds among the Christian Spaniards and were known by the name of Moriscos. They were most dexterous and industrious, and their influence upon embroidery in Southern Europe shows in the recurring use of the words Arabesque and Moresque.

Even after Philip III's wholesale expulsion, an appreciable number of Moriscos must have stayed in the country, for the final expulsion was in 1712. It is interesting to know that as a result of immigrant Jews being expelled from Spain in 1492, the manufacture of Point d'Espagne was affected, and that the most Catholic Kings of Spain found it necessary to pass an edict restricting the importation of gold work from Luca and from France, for the Spaniards still desired embroidery and lace, although the chief exponents had been driven from the country.

Royal Marriages.—The historian will also note the effect that royal marriages, betrothals and dowries have had upon the embroidery of different lands.

Spanish influences were observable in England when Eleanor of Castille married Edward I of England.

The Spanish Princess, Catherine of Aragon, influenced English needlework by the introduction of black work, as done in Spain. It consisted of all-over patterns of continuous scrolling stems with leaves, fruit and flowers in great variety. The material used was linen worked with black silk, and sometimes a gold or silver thread was added to give a richness to the otherwise sombre effect. The stitches used were couching, coral, open chain, knot, back and stem stitch. Picture No. 8 in the collection of His Majesty's pictures which is now being shown portrays a gentleman of the time of Holbein dressed in a scarlet suit of the period, with Spanish embroidery on the cuffs and the neck of the shirt.

Queen Mary I of England took as her consort Philip II of Spain, so that the ladies of the Court continued to come in contact with the stitchery and designs of Spain; and it is known that Philip had revoked a former Spanish edict and given permission for *punto de Agujo* of gold and silver and silk to be embroidered, as he himself liked to wear embroidered stockings of that same work.

Again, a little Spanish princess influenced the embroideries and lace of France, for Philip IV of Spain had a small daughter called Anne of Austria. In 1610, this little nine-year-old girl was betrothed to Louis XIII of France, and during her five years' betrothal a wonderful bedspread was embroidered; it is most elaborate and has a handsome border of beasts and birds and flowers; the four corner designs and centrepiece have the double-headed eagle and crown richly embroidered, and it is believed to have been completed for Anne's marriage at fourteen years of age.

Anne became the mother of Louis XIV and during his minority was, with Cardinal Mazarin, a power in the land; she influenced the use of Spanish lace made of gold and silver and sometimes embroidered in colours, and it can be seen in the portraits of the period. Another foreign alliance that influenced English embroidery was Charles II's marriage to Catherine of Braganza, for Bombay was part of Catherine's dowry and we have Indian bird and flower and tree designs being brought to England in a greater profusion than before.

One knows that trade with India had opened up in the latter part of Queen Elizabeth's reign, with the formation of the East India Company, but it was not till

later that the vogue for Indian pattern became so known and so appreciated that it was virtually adopted by English embroiderers and became our traditional Jacobean work.

Edicts against Embroidery.—During Philip IV's reign in Spain, an edict was made in 1623 repressing sixteen or seventeen different kinds of what we should call art needlework, which shows the proficiency of the Spaniards in every class of embroidery for adornments of every kind.

The historian will note with amusement how this stern edict came to be suspended again for the space of seven months. It seems that young Prince Charles Stuart went to Madrid to pay his addresses to the Infanta Maria Teresa, and the new falling collars, called Balonas or Valonas, had just come into fashion and were charmingly embroidered; the Spanish King liked the fashion and Prince Charles liked the collars too, so during his stay all the edicts touching embroidery and fashion were suspended in his honour, until it became evident that the marriage would not take place.

Prince Charles Stuart departed without a Spanish bride, but with an affection for the lace and embroidered falling collars which are later associated with Vandyck's portraits.

Geographical Influences

The geographer's approach to an interest in embroidery will be based on the effect that climatic conditions, soil and crops have had upon the work of any particular region.

Climate.—Large countries such as Russia and Canada have such tremendous contrasts of climate that there is a great diversity of needlework, in colour and in technique, and also in the type of pattern which is influenced by such varied neighbours in the case of Russia as the Finns in the north and the Kurds and Armenians in the south. These racial influences are strong, and therefore one sees Russian specimens of white work, embroidered lace, darned patterns on linens, cross-stitch—elaborate silk stitchery on taffeta where foreign influences reached St. Petersburg—rich coloured silks and metal threads in the south, where near-Eastern influences are apparent—and all these embroideries can be simply labelled Russian.

Where climatic conditions are severe, in countries such as Scandinavia and Russia, one finds that the peasants have used the long dark winters to produce beautiful embroideries on the homespun and hand-woven linens and woollen cloths. These embroideries are elaborate and the designs are passed on from one generation to another, incorporating well-liked motives and symbols; curtains, cushions, pillows and altar cloths were produced, as well as shirts and enrichments on women's clothes for use on special festal days.

Oddly enough, one finds that a very hot climate is also responsible for encouraging much needlework, often of rich bright colours, which looks well in brilliant sunshine against swarthy skins; strong sunshine has a curiously flattening effect upon colour, so that Japanese, Chinese and Indian embroideries are most effective in the land of their origin and tend to look forlorn or garish when exiled to our grey skies.

The climate of these three countries is conducive to sericulture, and the glossy

silks produced regulate the type of stitch, so that the embroiderer's aim is to keep as much as possible of the silken strand on the surface of the material; the stitches are very few in number, mainly satin stitch, long and short stitch and knotted stitch, so that little silk appears on the reverse side; the ground material is sometimes poor in quality, as in Indian work, where elaborate patterns will appear on cheap cotton cloth, or on a mixture of cotton and the hair of the ibex, which, when woven properly, produces the fine and unique cashmere cloth.

Portugal and Brazil, with their hot climates and formal social customs regarding women, produce delicate embroideries of fine technique, for the ladies are skilled in this delicate craft, which forms a very important part of their education; they spend hours sitting about in their houses or grounds, and embroidery is one of the polite accomplishments befitting their social status, whether done for secular or religious purposes.

Soil and Crops.—The soils and crops of a region have also affected the types of national embroideries in the past, although with the advent of machines and easy export and import one must expect changes and experiments in the years to come. For if a country produces flax largely, one will find a heritage of counted-thread work, either pulled and drawn or cross-stitched in traditional patterns such as one gets in Italy, where *punto di Rodi* and *Punto Barro Ricamo di Casal Guidi* and *Grosso Richelieu* are effectively worked on the easily pulled soft threads of the homespun linen, and where the cross-stitch of Assisi flourishes through the ages and is always pleasing to the eye. Indeed, just before the War, I was immensely struck with the charm of embroidered clothes worn by little Italian boys and girls of nursery age; late on summer nights one saw families strolling on the Lung' Arno, presumably of the artisan class, with two or three little children charmingly dressed in brief tunics or dresses with tiny touches of drawn thread or cross-stitch in perfect taste.

Indeed, it is interesting to study the work of the flax-producing countries and trace their use of that one particular stitch—cross-stitch—in its simple version or the many varieties, such as Montenegrin and long-legged cross-stitch.

One compares the methods and varieties used when the work has been done on hand-woven coarse linen in the past, or on the imported fine linens of Ireland and Dundee.

Cross-stitch occurs in China, Russia, Mexico, the Greek islands, Balkans, Czechoslovakia, Italy, Poland, Switzerland and Scandinavia. The last three mentioned are producing particularly interesting cross-stitch embroideries for the household or clothes, and we have in the Needlework Development Scheme collections delightful cushions and towels from Poland; large handsome bed-covers are on the way from Switzerland, with strong traditional motives incorporated into the designs; the Scandinavian countries have recently made excellent monochrome cross-stitch designs on coarse linen, for they were greatly handicapped over materials during the German occupation of Norway, and found that black thread was the only thing procurable and so used it with great effect while coloured threads were unobtainable.

Just before the war, German embroiderers were making very modern church vestments, such as stoles and banners, of coarse linen and jute worked in cross-stitch

designs of distorted figures. The technique and colour were pleasing, but the designs were distasteful to religious people in that the distorted and top-heavy figures were not the result of childhood's naïveté, but of a queer debased mentality which has not been confined to embroidery design only.

Other soils and crops have produced different weaves of material and the mixture of cotton with fine wool accounts for the famous *Pânza* material of Rumania, which is rather akin to georgette or voile in texture; this *Pânza* has a certain springiness and solid blocks of pattern are embroidered over one thread at a time. The result is handsome and entirely typical of Rumania alone, in that so delicate a material should be capable of such a wealth of embroidery.

The Greek islands and mainland also weave an attractive crinkly material made of cotton and wool and called *Kukulariko* (coo-coo-la-ricco) which again tends to be stitched in solid blocks of attractive soft colours reminiscent of Byzantine colours, although the *Kukulariko* can be woven with a greater weight suitable for men's coats and trousers.

Cotton grows in Turkey, Rumania and Greece, not the fine-grade cotton of Egypt, but a coarser plant from which a native muslin-like material is made; this has been much used for the famous old head-scarves, with their richly embroidered borders of flowers; the stitches are mainly double-running, satin and eyelet hole and often metal threads are added as an embellishment. These head scarves are found along the coast of Albania, Greece and Turkey and formed an important adornment for the women when engaged in their social activities at the bath.

The hand-woven linens of Italy have been most attractive for their soft silken feel, and distinguished work of extreme fineness and delicacy has been possible since the sixteenth century.

The linens of Russia, which were much exported between the two great wars, were interesting in their coarse texture, and were woven on the narrow looms of the peasants in their own homes; no two pieces of Russian linen were alike in texture or greyish colour, but the material was very strong and hardwearing and particularly adapted for gay peasant embroideries.

The Hungarian soil also grows flax and the people of Kalotaszeg have a hand-woven linen of their own called *Fodorvasz*, meaning literally "frizzled linen" which is quite unique in texture.

Apart from soil and climate one finds that the mountain ranges, mountain passes and great waterways like the Danube have influenced designs and embroidery.

Waterways.—For centuries the Danube has been important for trading purposes and, rising as it does in the Black Forest, and flowing through Northern Austria at Linz, flowing past Vienna, and into Czechoslovakia at Bratislava, by Budapest, through Hungary near Belgrade into Jugoslavia, and on to Rumania and the sea, one realises why the embroidery and pattern of these countries are indistinguishable at times, for the movement of the peoples up and down the great river must have been constant. Trade prospered and people intermarried, so that the knowledge and skill of one district filtered through to other places in the Danube basin, and the great heritage of embroidery with its lavish use of cross-stitch and rich flowery designs in brilliant colouring became a widely spread tradition of the great Danube waterway.

The use of the Persian pink and pomegranate with its many varieties, occurs in

all Czech embroideries, and seems to indicate either the influence of the Eastern races beyond the Carpathian Mountains (the districts from which the Czechs came to Bohemia) or the result of centuries of trading with the near-Eastern races.

Mountains.—The mountain ranges which have cut off Albania, Greece and Turkey from the north have caused these particular countries to owe many of their ideas and contacts to the other side of the Mediterranean, where access by sea was constant and where the movement of the peoples, due to travel, trade or persecution, tended to bring together the craftsmen of Egypt, Asia Minor, Turkey, Greece and Albania.

Italian and Persian influences have also been felt in these regions, owing to the movements of people between Italy and Greece and Turkey and Persia, so that it is sometimes very difficult to give a verdict on the origin of a head-scarf or other embroideries of that part of the Mediterranean.

The range of Alps in the north of Italy has tended to keep Italian embroideries uninfluenced by the adjoining countries, but, in the past, there was much sea-trade between Spain and Italy; and these two great religious nations produced rich church vestments that are again sometimes difficult to distinguish one from another though the Spanish decoration is usually more ornate than that of Italy.

In early times one of the trade routes between Italy and Germany was through Styria in Austria, and many pattern books and designs produced in Italy were sent north through Styria, so that the weaving, embroidery and clothes of this region were much in advance of those of other peoples in the Hungarian plain, because of contact with their more cultured neighbours.

This examination of climate, soil, mountain barriers and waterways shows that traditional embroidery of all regions is affected by them in some degree, and is not merely the result of a whim or passing idea that flits through any woman'smind.

Technique and Colour

Mention should now be made of colour and technique, and there are a few generalisations, which are usually accepted, but only with the reservation that exceptions are frequent.

In Northern Europe there is a tendency to produce much white work, or work in one colour, and variety is obtained by the use of many sorts of stitches, so that the texture of the embroidery is varied. This is most apparent in the *Hedebo* work of Denmark, a type of embroidery exclusive to Denmark and of which little is known outside the country of origin. The embroidery was done for themselves by the dwellers on the heath (*heden*) and these country folk worked on strips of hand-woven linen, with the pattern arranged in handsome bands subdivided into squares or triangles. Within these spaces were embroidered Renaissance ornaments, geometrical patterns, or conventionalised flowers, trees or animals, and the stitches used were chain and satin stitch with lace stitch fillings worked over foundation threads laid across the open spaces. The finished *Hedebo* embroideries were wonderfully interesting from the technique and design standpoint, although the work was all in white or natural colour, and strong and lasting in quality and capable of being passed down from one generation to another, for *Hedebo*

embroidery was kept exclusively as a personal possession showing the affluence of the household, and did not reach the open market at all.

Where colour is used lavishly there is usually less variety of stitch, for the embroideress is so occupied with arranging gorgeous shades of cotton or silk that she may be content with three or four varieties of stitch only.

Thus we have handsome embroideries of geometric patterns using a wealth of colour, but worked in cross-stitch only. We have materials decorated with conventionalised plant ornament and much colour is used with only knot, stem and satin stitches utilised.

In the Eastern Mediterranean one finds colour used in two distinct ways for Greek island embroideries: it may be that the embroideress is attracted by one dominant colour and others are strictly subordinated to the main effect; or the embroideress works with alternate colours and obtains her effect most attractively in a balanced way.

In the Far East, where silk is mostly used, the embroideress tries to keep all the thread on the surface and will economise most ingeniously so that no wasted strands appear on the reverse; and in whatever part of the world workers are using gold and silver threads for secular or church work, their one idea is to choose stitches that enable the precious threads to be on the surface, because of expense and because of the awkwardness of manipulating metal threads through the ground material. Both workers in floss silk and workers in gold thread appreciate the effect that light can give to embroidery, and how a difference in direction—if not in the choice of stitch—can give an added interest by the play of light and shade. This is very apparent in some Indian work from Kashmir, where large hangings of soft blue cashmere are worked entirely in creamish silk using only one stitch; but variety is given by the different directions in which the needle has placed the thread, so that one is not conscious only of blue and cream, but of blue decorated with bright cream, cloudy oyster shades and pearly shadows of great charm, as the silken stitchery gleams in the light or falls gently into shade.

Portuguese embroideries in the sixteenth century were noted for the elaborate designs worked cleverly with more silk than linen showing on the right side, and with barely an outline showing at the back when they were reversed; there are ancient specimens of robes and altar-cloths with rich colourings and designs suggestive of Indo-Portuguese or even Chinese influence, and with designs of birds and butterflies and dragons. When one remembers what a powerful seafaring nation the Portuguese were at that time, such Eastern influence is understandable.

Northern Portugal now produces much fine white work which is reminiscent of Irish and *Broderie Anglaise*, and further south its peasant embroideries are gay with vermilion, yellow, bright pink, green and black; the peasant embroideries are on hand-woven linen, and show an inherent sense of design, although worked by isolated women. Their usual method is to copy traditional patterns or to go straight to nature and conventionalise as they go, adapting flowers, fruit and leaves for their purpose, but never tracing. The favourite motives are orange, vine, olive plants and carnations growing from vases intermingled with heart shapes.

Spanish embroidery is often in black or in white alone, or uses pinks, yellows, blues, greens and reds in about the same proportion. Rumania has red and black as

its favourite colours, but pale blue, black and yellow are well-liked, and it is noticeable that a touch of black is typically present in all but white work.

Constructional Decoration

It should be noted how, in Rumania, Jugoslavia and Russia, the peasants have evoked a method of constructional work turned to a decorative factor, for their hand-woven linens are made on narrow looms, so that it is absolutely necessary to keep joining pieces of material for almost any garment. Although a robe may be richly ornamented, nothing gives way to sound construction, and every place where hard wear comes is beautifully and practically strengthened with decorative seams, ingenious edgings and very sound faggoting or needle-weaving so that the decoration is truly structural.

Some of the loveliest colourings of all are those of Norway, where they dye their threads and woollens with their native dyes and produce soft faded shades of blue, bluish-green and faded yellows, warm browns and russet reds that have a quality all their own. A Norwegian girl's notebook with specimens of dyed wools done by herself during the German occupation amazed one by the vast range of shades and colours obtained by brews of moss and plants and bark of trees; the colours were indeed reminiscent of the earth and fields and mountains and showed what country folk could do without the aid of chemists and scientists and their modern concoctions.

Portraits

The artist or traveller roaming about the art galleries of the world is struck by the pictured elegance of kings and queens, whose portraits are enhanced by the rich setting of embroidered robes, or cuffs or caps. The portrait of Richard II (1367–1400) in Westminster Abbey shows him wearing a beautifully embroidered tunic with the letter R topped by a crown.

In the National Portrait Gallery is a painting of the Lady Margaret Beaufort, that noble foundress of lectures on Divinity in the University of Cambridge; she was a distinguished woman, the mother of Henry VII, and after the battle of Tewkesbury in 1471 became heiress to the Lancastrian claim to the English Crown. The Lady Margaret's portrait shows her wearing a hood embroidered in Spanish work which is said to have been introduced into England with Catherine of Aragon about 1502. The Lady Margaret died in 1509, which seems to show that during her lifetime she followed the fashions and chose to be portrayed in one of the latest continental modes of that period. Spanish work is still seen thirty years later on the cuffs of Henry VIII's widow, who by her second marriage became the Lady Catherine Seymour.

Contemporary portraits of Henry VIII, Edward VI, Mary Queen of Scots, Queen Elizabeth and Viscount Montague show how embroidery was used successfully on the costumes of the nobility of the fifteenth and sixteenth centuries.

We have a fine heritage from the past, and enough has been said to show that an interest in embroidery should not be under-estimated, for it can appeal to the designer and craftsman, the artist and the traveller in foreign lands as part of their necessary education and culture.

We have owed much of our success in embroidery to foreign influences, and now

in this transitional period, while post-war forces sweep the world, use must be made of the accumulated experience of the past which has stood the test of time and is called tradition.

A new style will evolve, for pressure of changing ideas and changing conditions will produce a style that has its place in our everyday lives in this machine age; and those people who have knowledge, skill and experience and the eye to see, will watch with interest the further development of this most cosmopolitan of all the crafts—embroidery.

THE CHAIRMAN: I am sure that we have all had a most delightful afternoon, and not the least delightful part of it has been the admirable illustrations shown on the screen and the interesting way in which they have been explained to us. I should have liked this meeting to go on for much longer and Miss Kohler to have taken us round the room and told us all about each piece of embroidery shown here. I should like to propose a vote of thanks to Miss Kohler for her interesting paper and for lending us all these lovely things to look at.

On the motion of Mr. F. H. ANDREWS, a vote of thanks was accorded to the Chairman for presiding. The votes of thanks were carried with acclamation and the meeting then terminated.

[*Illustrations showing a number of Miss Kohler's exhibits will be found on pages* 71–74.

THE DOCUMENTARY FILM

By Sir STEPHEN TALLENTS, K.C.M.G., C.B., C.B.E.

COBB LECTURE

Fourth Ordinary Meeting, Wednesday, November 27th, 1946

The Right Hon. L. S. AMERY, C.H., *in the Chair*

THE CHAIRMAN: Some 22 years ago, at the beginning of the Baldwin Government in 1924, I found myself grievously disappointed because Mr. Baldwin could not see his way to implementing certain modest tariff preferences which had been agreed at an Imperial Economic Conference the year before; but as I was not prepared to be altogether defeated, I insisted on securing the money equivalent of those preferences to be devoted to the whole problem of advertising, and in every way encouraging the purchase in this country, of Empire products.

Having got money and a few vague ideas, the next thing was to find the man to carry them out. Somehow or other at an early stage I made up my mind that there was only one man who would serve my purpose, and his name was Colonel Stephen Tallents, who, I gathered, had acquired, in administering the city and province of Riga and the equally interesting province of Ulster, the kind of experience that I thought would stimulate imagination and lead to a determination to overcome difficulties. In fact, I held up the whole of my proceedings for nearly three months in order to make sure of getting him.

Between us we collected a band of enthusiastic colleagues and, I think, developed something in the nature of a new technique in the promotion of interest in the Empire and in its products. For instance, all poster advertising since then has, in my opinion, been not uninfluenced by the artistic posters which the Empire Marketing Board first started those many years ago. The whole conception of the encouragement of research by modest grants, and still more by finding the very modest sums required to encourage research workers in one part of the Empire to visit other parts, also continues to be recognised; and in the same way our modest beginnings with documentary films have

developed even after the Empire Marketing Board came to an untimely and, I still think, a wholly undeserved, end, owing to the shortsightedness of officialdom. In fact, the seed that we sowed has become a mighty tree, and it is of that tree that Sir Stephen Tallents is going to say something in the next few minutes.

I would add only a few more words. The duties of a Civil Servant are undoubtedly what the textbooks call regulative. They have to be very careful of precedent, and they have to keep erratic Ministers on the rails. But it is entirely untrue to suppose that in our system of government the initiative and imagination of the Civil Servant have not played a great part. It was, I think, said by Sir William Harcourt long ago that the value of a Parliamentary Minister is to tell the Civil Servant what the public will not stand; but sometimes his value lies, I think, in realising what the public will stand and giving a bold and imaginative Civil Servant a free run. When I think of what men like Lord Morant did in an earlier generation, and what more recently Lord Hankey and Sir Stephen Tallents have done, I would certainly not underrate the creative part that the Civil Servant has played as a partner with the political leadership of this country.

That is, I think, all that I need say by way of introduction, and I will now ask Sir Stephen Tallents to give you his address.

Sir STEPHEN TALLENTS then delivered the following lecture:

No one could have enjoyed a more generous—a more characteristically generous—introduction to this audience than Mr. Amery has just given me. Thanking him very sincerely, let me say what a pleasure it is to me to find myself—if only for an evening—once more under a chairmanship from which I profited so much twenty years ago. There could not have been a more appropriate chairman than Mr. Amery for this subject. For no movement, I should be prepared to wager, has ever had a more clearly defined birthplace than that of the British documentary film; and the nursing home in which it first saw the light was Mr. Amery's room at the Dominions Office, on the morning of April 27th, 1928. Six men were present at that accouchement, of whom five are still living—Mr. Amery, Mr. Walter Elliot, Sir John Craig (now Deputy Master and Comptroller of the Royal Mint and Engraver of His Majesty's Seals), Mr. John Grierson and I. None of them, it is safe to say, saw just what would come of that meeting. But some of us at least felt that it was important. I—partly because it had amused me, but partly also because I felt it was significant—made a detailed note of it at the time; and, as I have seldom done with the record of an official meeting, I kept the note. I will describe what passed at the birth presently—and this is perhaps the moment to warn you that my talk will deal more with the history of the early documentary film movement than with its latest developments or its future prospects. It is always better to speak of what one knows first hand. But before I tell the story of the birth, let me recall briefly how that bedside meeting came about.

Mr. Amery was Chairman of the Empire Marketing Board. Mr. Walter Elliot was Chairman of its Film Committee. I was the Board's Secretary. Very early in our work we had been impressed with the opportunity, which cinema presented, for bringing the Empire alive to the imagination of the public. One summer afternoon in 1926—the first summer of our work—I had driven to lunch with Mr. Rudyard Kipling in his house at Burwash. Mr. Kipling, who had so far fought shy of the films, confirmed our belief in the possibilities of cinema and held out hopes that he would himself guide the making of a film for us. This seemed to me a magnificent opening. I had little difficulty in persuading my Board to pursue it. I had much more difficulty

in selling the idea to an extremely sceptical Treasury. In the end, however, I got leave to employ a man named by Mr. Kipling as particularly suited to work with him; and we embarked on a film of fancy called "One Family", which began gloriously with shots of society ladies impersonating the different Dominions in the Throne Room at Buckingham Palace and ended its main theatrical career less happily after a week's run in the Palace Theatre. In justice to its maker, I should add that he produced, as a by-product of his big film, a particularly charming short film, "Southern April", which Miss Lejeune praised on its appearance as an example of "what lovely things can be done with a camera and a microphone by a man both of sensibility and idea".

While " One Family " was still in embryo, a man called at my office one morning with a letter of introduction from Robert Nichols, the poet, which described my caller as having ideas in harmony with those which I had discussed with the writer. My caller gave his name as John Grierson. I found that, after service in mine-sweepers during the 1914 war, he had gone out to the United States as a fellow of the Rockefeller Foundation and had there studied psychology in terms of American cinema. He had never as yet himself made a film. I took to Grierson at once, and felt that here was a man that we needed and must enlist in the service of the E.M.B. I cannot say with equal truth that I fully grasped at that first interview the theories which he expounded to me. For their full comprehension I would refer you to that interesting book—*Grierson on Documentary*—which Mr. Forsyth Hardy has lately edited and in which he has gathered Grierson's writings and talks from 1926 till almost the present day. But I think I can briefly summarise what Grierson was thinking at that time. He was shocked at the meagre content of community life everywhere. Its enrichment depended, he thought, on a better understanding of the stuff of which it was compounded. That better understanding could not be secured by the orthodox methods of academic education. " Education " he was to say of the public a few years ago, " has given them facts but has not sufficiently given them faith." It was necessary to touch the imaginations of the people—not merely to impart facts to them; and their imaginations could best be touched by eliciting and presenting to them in a dramatised form the exciting material which he found in the real life around him.

Grierson had obviously come to these conclusions as a result of his own thought and observation. I found an apt confirmation of his view the other day in Walt Whitman's *Backward Glance O'er Travel'd Roads*—" Whatever may have been the case in years gone by, the true use for the imaginative faculty of modern times is to give ultimate vivification to facts, to science, and to common lives, endowing them with the glows and glories and final illustriousness which belong to every real thing, and to real things alone."

He was shy in those days of talking much about the artistic side of the job; and I doubt if he would to-day insist, as emphatically as I should, on the importance of the artistic element in a documentary film. He was up against not only the commercial cinema, as we then knew it, but against the talk of art for art's sake among those who had revolted from it or failed in it. But he was as delighted as I was when, in our later Post Office days, I discovered, in a letter of John Stuart Mill to Thomas Carlyle, the saying—" It is the artist alone in whose hands truth becomes

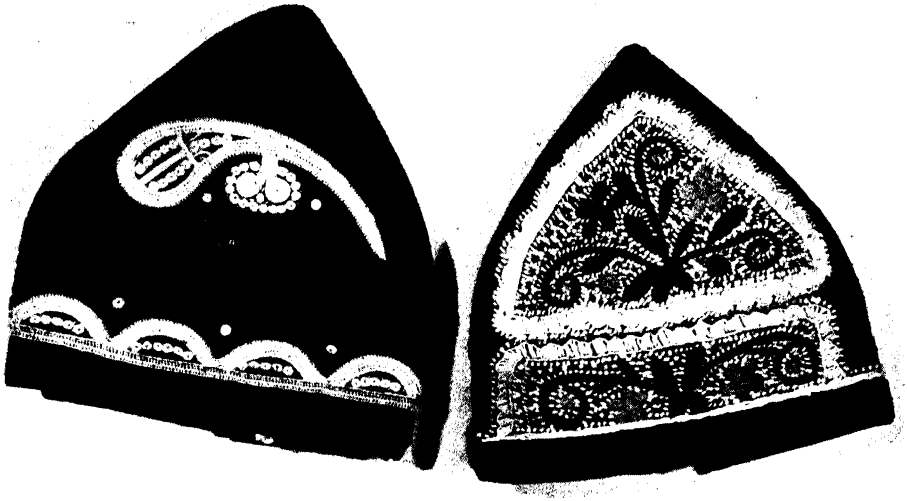


FIG. 1.—*Hungarian men's caps in twilled black material worked all in white knotted stitches to give a raised effect*



FIG. 2.—*Austrian embroidery on linen, worked with linen thread in blue cross stitch*

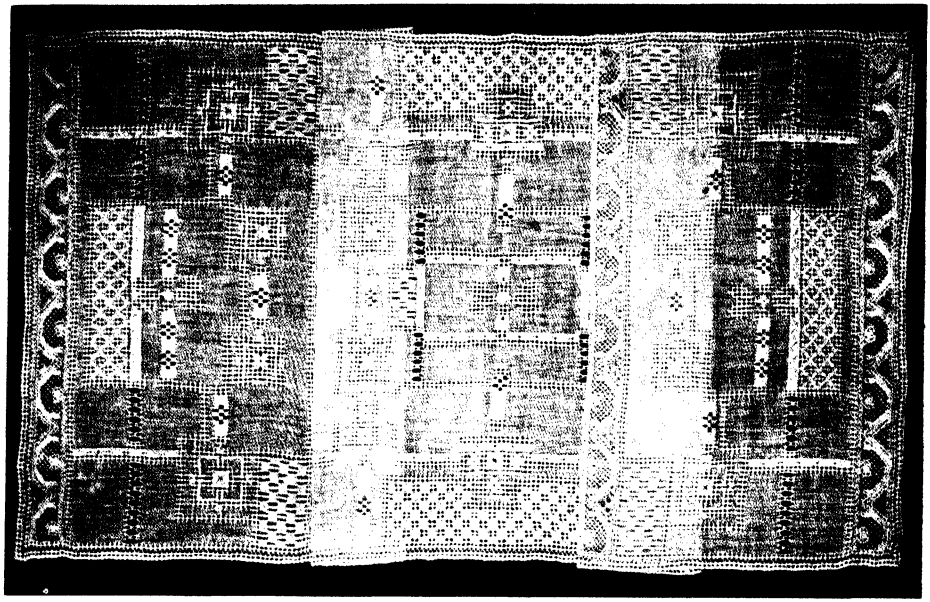


FIG. 3.—*Swedish linen and lace runner, worked in counted and pulled stitches, typical of the Darlane district*



FIG. 4.—*Venetian cloth of fine organdie material magnificently embroidered in fine white stitching depicting the planets and stars*

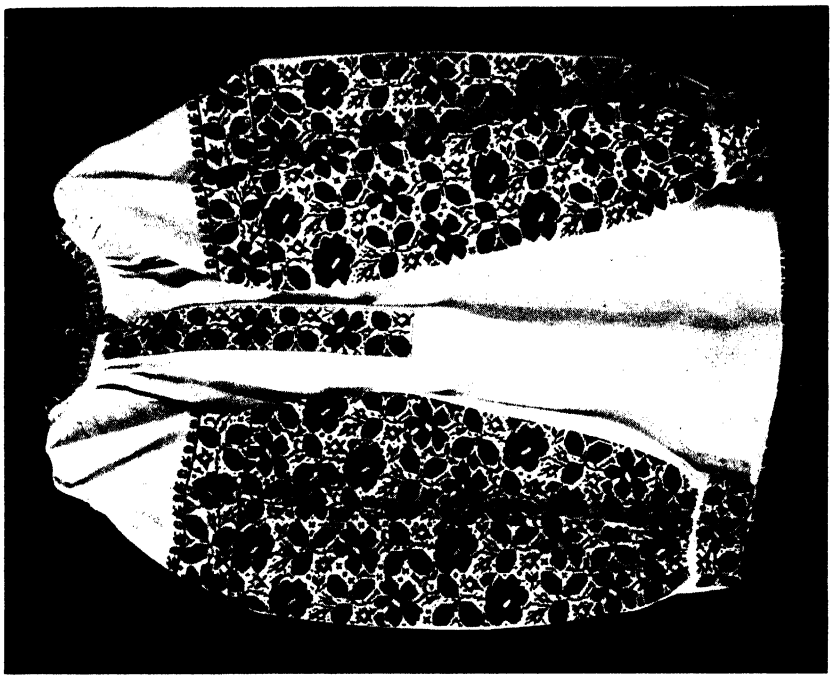


FIG. 6.—*Viennese man's shirt of heavy linen, elaborately cross-stitched in maroon, blue and black threads*

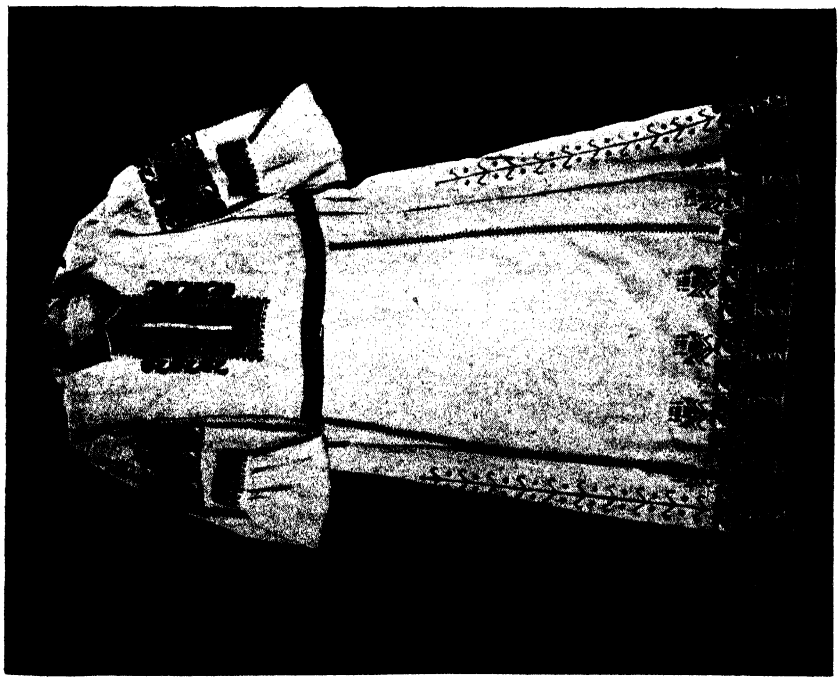


FIG. 5.—*Heavy silk garment from Bulgaria, embroidered in traditional pattern*

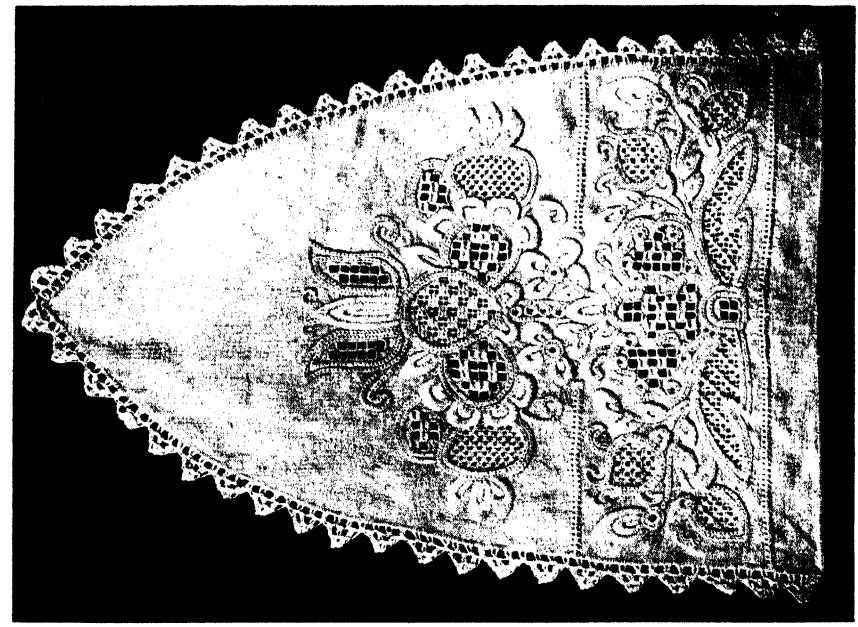


FIG. 8.—*Danish traditional* Hedebo *work on white linen with white thread*

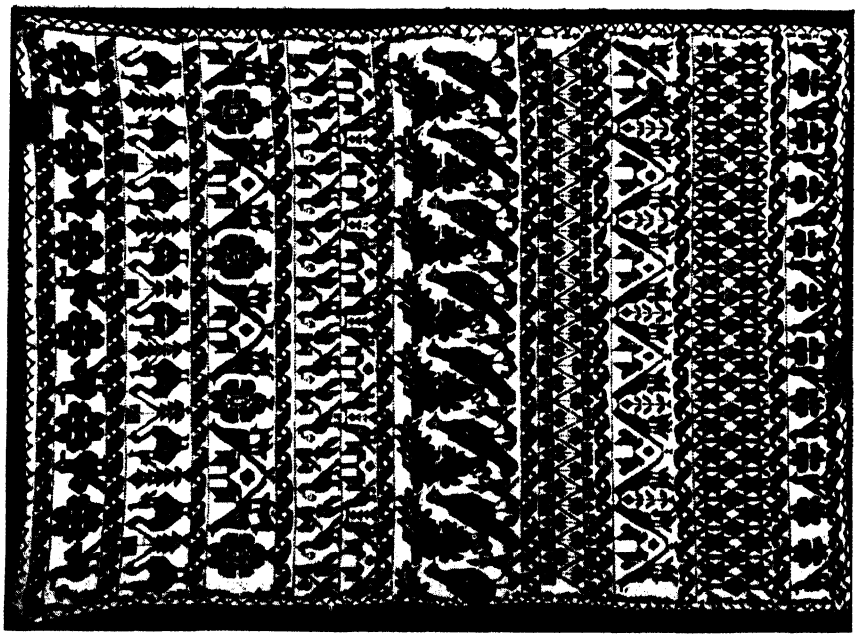


FIG. 7.—*Mexican sampler with varied bird borders worked in black wool running stitches*

impressive and a living principle of action." That saying has done hard labour for both of us since then.

Cinema was not the only medium to which Grierson looked for the achievement of his purpose. It was really a chance that made him at that point choose the film. The British Empire was by no means the only raw material that stood ready for such treatment. But it so happened that we at the E.M.B., thinking in less philosophical terms than Grierson, wanted to " bring the Empire alive," as we used to say, through every medium that we could employ; and our particular need provided Grierson with an opportunity for embodying his theory in practice.

With " One Family " on the stocks, I could not hope to get the Treasury at that stage to allow us to employ a second film officer. But one of the great virtues of the E.M.B. was that we had a certain discretion to spend money for experimental purposes. I therefore commissioned Grierson to prepare a series of memoranda on the use of the film in other countries. He produced memoranda showing in particular how the non-theatrical distribution of films was going ahead in France and Germany. He also suggested that we should arrange, in the cinema that the E.M.B. had lately installed at the Imperial Institute, a series of private showings of significant films.

On me at least those displays, confined to a small but distinguished invited audience, made an impression that is vivid to this day. We watched " The Covered Wagon " and " The Iron Horse." We included some British films in particular specimens of that beautiful " Secrets of Nature " series, which Percy Smith and Mary Field were making under Bruce Woolfe's management; and let me pay a warm tribute here to all the pioneer work which Bruce Woolfe has done for British documentary. We marvelled at one of the earliest microscopic films made by Dr. R. J. Canti of St. Bartholomew's Hospital—a lovely job. We saw Flaherty's "Nanook of the North" and "Moana", and Calvalcanti's "Rien que les Heures." But unquestionably the most exciting films that we saw on that screen were the early Russian films. Eisenstein's "Potemkin", Turin's "Turk-Sib", Pudovkin's "Storm over Asia"; then—a film which I recall with special affection —Dovjenko's "Earth", that "psalm of the soil", as the Russians called it.

Grierson by now was thirsting to try out his ideas in the actual making of a film. We, our minds convinced by his conversation and our eyes opened by what we had seen at the Imperial Institute, were anxious that he should have that opportunity. But the Treasury sought to overrule a recommendation of the Board, taken at a meeting at which they had not troubled to be represented. Mr. Amery rebelled; and the result was the meeting in his room which I mentioned at the outset.

Our plans for this film had not been laid without guile. It was, by common consent, time that the E.M.B. did something for home fisheries. Grierson had served during the 1914 war in minesweepers. Mr. Arthur Michael Samuel, the Financial Secretary to the Treasury, had studied the history of the English herring fisheries, and had committed his learning to a book—*The Herring; Its Effect on the History of Britain.* Mr. Samuel opened our meeting with a salvo. As a director of Apollinaris, he knew much about advertising; and he could assure us that it was sheer waste of money to think of increasing the sale of Empire products by films. Mr. Walter Elliot and Mr. Amery, in that order, explained that this was to be a background film, designed to create an atmosphere by presenting English life and character. Then we

dangled our herring bait in front of the Financial Secretary. Mr. Amery explained firmly that responsibility rested with the E.M.B. and with himself, acting after he had received their advice. The meeting ended with Mr. Samuel genially offering to help us with his deep knowledge of the history of herrings and ourselves as warmly welcoming his offer. The voice of the official Treasury insisted, as a postscript to our conference, that one " semi-expert " and one office man should be sufficient for our needs.

It was a very modest enterprise on which we thus embarked. But then, as Grierson once wrote—" If the Civil Service or any other public service must have its illegitimate infants, it is best to see that they are small ones." Yet the decision to embark, you will have noted, involved two top-rank Cabinet Ministers; and the making of the film created, I am sure, agonies as sharp as ever attended the making of, say, Eisenstein's Mexican film or "Caesar and Cleopatra." A drifter, the *Maid of Thule*, was hired at Stornoway, chiefly on the strength of her crew's supposed photogenic quality. John Skeaping designed a cabin set, which was erected near the harbour. A fisheries protection cruiser obliged with power for the lighting. The underwater scenes were supplied by dogfish chivvying small roach about a tank on the Plymouth Marine Biological Station. Then the *Maid of Thule* couldn't find the herrings, and operations had to be transferred to another drifter at Lowestoft. Next the chairman of the company, with which a contract had been made for the film's production, turned up in my room one evening with a long face to declare that it was a predestined flop and had better be abandoned. That was one of the real crises of my official life. But I left Grierson to deal with him. Production was resumed. On November 10th, 1929, the Film Society put on " Drifters " in a programme with " Potemkin," and it won much applause in the theatre and praise thereafter from a number of the critics.

We might at this point have embarked Grierson on a succession of films in the manner of " Drifters." We were certainly tempted to do so. In fact, on his advice, we refrained. We set ourselves to build up a school of documentary producers and to develop a non-theatrical system of distribution. I must not pursue the story henceforward this evening in the same detail as I have devoted to the accouchement of " Drifters "; but let me follow, if only briefly, those two threads.

The small collection of films already housed at the Imperial Institute was enlarged, chiefly thanks to the generosity of the Canadian Government and the Canadian National Railways. (I like to remember what a remarkable part, at critical stages of the British documentary film movement, Canada has always played.) The Library grew rapidly. In the year 1932 it issued over 6,000 films, and the audiences it served, in the Institute and up and down the country numbered just short of 1,000,000 The Library was in jeopardy when the E.M.B. fell. But we were able to take it to the Post Office and there to issue its catalogue in a new pillar-box red cover. In spite of an ingenious preface of justification, the Select Committee on Estimates declared rather heatedly a few years later that it had no business to be in Post Office keeping; but a last minute sortie dragged it under shelter at the Imperial Institute, where, with Sir Harry Lindsay as its guardian and with grants from Canada and the Imperial Relations Trust, it held out till the last war. The Ministry of Information then took it over and developed it almost beyond recognition into the great Library of films on

which it based its immense non-theatrical circulation. It is issuing, now, I hear, 10,000 films a month.

I turn to the development of a school of documentary producers. As soon as " Drifters " appeared, young men and women—at first in their tens and then, after an advertisement in the agony column of the *Times*, in their hundreds, applied to be enrolled in the E.M.B. Unit. All of them were enthusiastic—" for art," Grierson said afterwards, " for self-expression and the other beautiful what-nots of a youthful or simply vague existence." He picked just a few from among them. Basil Wright, who went straight out from seeing " Drifters " at the Tivoli in search of Grierson's address, beat J. D. Davidson by a short head. Evelyn Spice, Arthur Elton, Edgar Anstey and Marion Grierson came in a little later. Then J. N. Davidson, Donald Taylor and Stuart Legg joined us. Paul Rotha, before he went on to open a distinguished documentary career with " Contact," made his first film with us—a charming record of the English-bred bulbs which we had given the Office of Works to plant in St. James's Park.

You will recognise from those few names alone how largely the leaders of the documentary movement came out of that lowly stable. They started work in a small workshop, in which the cutting room was also the projection theatre; and it was a proud day when we were able to turn an underground cellar in our main offices, where no one else was willing to work, into what we called a theatre for them. These premises, as a complacent official report of the time remarked, contained " limited studio accommodation, but are very efficiently equipped for the production and editing of documentary films." They were efficient only in the meagrely paid but eager men that they contained. Occasional trade visitors, coming as often as not to save themselves a sea journey by the purchase of shots of sea-gulls from our " Drifters " material—we became very proud of our seagull monopoly—derided what Cedric Belfrage called our " laughably primitive conditions."

Nevertheless by 1931—we had then got better quarters for the Unit in Oxford Street—Miss Lejeune was able to write— " At the moment there is practically no other workshop than the E.M.B. in which a film apprentice can learn his work with a mixture of imagination and common-sense." In that workshop the team in their apprentice days made films of a considerable variety. They made " poster " films, as we called them, extolling the virtues of home-grown tomatoes and National Mark eggs. " Conquest," a film slung together from widely gathered existing material and depicting the first invasion of North America by Europeans and the settlement of the Canadian prairies, did good service in the schools till our leave to use material from " The Covered Wagon," which it contained, expired. They went on to more ambitious work. Basil Wright's "O'er Hill and Dale" portrayed the lambing season in the Cheviots. Evelyn Spice made " Spring on the Farm." Arthur Elton in " Upstream " told the story of the Scottish salmon fisheries. The great Flaherty himself, collaborating with John Grierson in " Industrial Britain "—a memorable film—destroyed the commercial fallacy that the life of our industrial towns and their smoky atmosphere were not fit subjects for the screen. Elton, again, in his " Shadow on the Mountain " broke new ground in bringing alive in popular terms the work of Sir George Stapledon's Plant Breeding Station at Aberystwyth.

They did not merely make films: they spoke and wrote about them. They helped

to build up a body of responsible film criticism. They argued hotly among themselves; but fundamentally they maintained a common front; and the loyalty of those days has, I like to think, been happily preserved in the documentary movement. They were at least as closely in touch with the unofficial as with the official world; and thus they gave the rest of us that asset so valuable to a government department—a window wide open to the world outside it.

The unit began to travel overseas. Wright brought back from the West Indies " Cargo from Jamaica," " Windmill in Barbadoes " and much material, which was uncompleted when the E.M.B. died, about the Imperial College of Agriculture at Trinidad. Anstey, from a voyage to Labrador in H.M.S. *Challenger*, brought back " Uncharted Waters " and "Eskimo Village." The unit was called upon to make films for other Government departments and produced, for example, " The New Operator " for the Post Office, which had been roused by Mr. Attlee to a sense of its need of publicity, which Sir Kingsley Wood afterwards was to cultivate with much advantage. Its members went out to make films for unofficial sponsors—" New Generation " for the Chesterfield local education authority, " Liner Cruising South " for the Orient Company, and " Song of Ceylon " for the Ceylon Tea Propaganda Board. Then the axe fell. The E.M.B. was dissolved; and its Film Unit, thanks to the encouragement of Sir Kingsley Wood, but not without painful negotiations with the Treasury, moved over to the Post Office.

Once the Unit had got acclimatised to St. Martin's-le-Grand, its output went ahead. Cavalcanti joined it: so did Harry Watt and, later, Humphrey Jennings. It lashed up a sound-recording studio at Blackheath. They experimented not only with the recording of sound—then in its early days—but with specially-written scripts and music. W. H. Auden wrote the script of " Coal Face " and " Night Mail." Benjamin Britten, Walter Leigh and Maurice Jaubert—the last two to die before their time in the recent war—wrote music for us. Among the films that the Unit made in those days were " Six-thirty Collection," " Night Mail," " Cable Ship," "North Sea", "Under the City" and "We Live in Two Worlds", of which J. B. Priestley wrote much of the script. No one who has seen it will forget Len Lye's gay " Colour Box". I learned at the Post Office a lesson I have never forgotten, and which I commend to all employers of large staffs whose work is performed in places remote from the public eye. Films that dramatise such work and bring it vividly before the public have a double function and a double reward. They not merely enlist the sympathy and co-operation of the public; they are a profound encouragement to the staff concerned.

And now, matured in a hard and sometimes discouraging school, members of the Unit began to move on to other opportunities outside the Government service. The British Commercial Gas Association and the Asiatic Petroleum Company employed Elton and Anstey to fine effect. In the end Grierson himself left the Government service for a wider field. The Unit continued, and in the days of the Ministry of Information became the Crown Film Unit, now under the leadership of Alexander Shaw.

Thus far I have been able to describe the growth of the British documentary film movement with some degree of inside knowledge. Let me now attempt more briefly the harder task of reviewing its later growth. There are bound to be many gaps in my

review and some lack of balance. I hope that the discussion presently will help to fill the gaps and redress the balance.

This audience will need no reminding of the outstanding documentary films produced in this country during the war—"Target for To-night", " Desert Victory", "Fires were Started", "Lift Your Head, Comrade", "World of Plenty", to name only a few of them. Other films, shorter but not less technically perfect—"The Harvest shall Come", "Words and Actions", "Rescue Reconnaissance" and the " Pattern of Britain " series, for example—have carried on and developed the documentary tradition and, thanks to the Ministry of Information's wide-ranging non-theatrical system of distribution, have been seen by millions outside the regular theatres—in factories, in village halls, in schools. That output, by the by, reflects the benefit of public funds made available for the steady production of a continuous programme. John Grierson's remarkable work as Film Commissioner for the Dominion of Canada was an outstanding achievement of the war years and deserves an address of its own.

In the process which led up to that achievement, British work has notably influenced production abroad, not least in the United States. I wish it could claim a share in the remarkable job which Pare Lorentz did some years ago for their Department of Agriculture in " The Plow that Broke the Plains " and, yet more notably, "The River". (I shall speak of that film again in another context in a few minutes.) But I think that Pare Lorentz's work has an early Russian rather than a British ancestry. Certainly the influence of British documentary was felt, and is still being felt, widely and deeply on the Continent.

That influence is surely also clearly traceable in certain feature films. Here I speak with reserve and am prepared to be contradicted. But is it not traceable in, for example, " Millions Like Us " and Noel Coward's " In Which We Serve " ? I find it difficult to believe that it did not contribute to John Ford's version of Steinbeck's "Grapes of Wrath". Now this autumn Harry Watt in "The Overlanders" has shown us the true documentary tradition inspiring a full-length feature film that realises, as Basil Wright has lately noted in the *Spectator*, some of the E.M.B. ambitions of 1930.

Now that Europe, or at any rate Western Europe, is open again, assessments are becoming possible of the international place of British documentary. There have been international film festivals at Venice and Cannes and a British film festival at Prague. I have spoken to men who were present at each, and the impression I gather is this. The Russian school has lost, for the time at any rate, its former pre-eminence. Other European countries are handling the simpler themes which contented our documentary makers eight years ago, but handling them sometimes with a delicacy and a humour that British documentary has not always achieved. You may have noticed the impression which the *Times* film critic recorded of the Cannes Festival. Our documentaries, he reported, were distinguished for " their deep and serious interest in the sociological problems of the day." But he was struck with the light-hearted dexterity of some of the Continental producers, and the " humour and humanity " which the Danes had introduced into " The Brigade in Sweden". Evidently the British movement, from now on, is going to face competition. The five members of the Board which runs that excellent publication *Documentary News*

Letter have lately visited between them each of the five continents. They have just reported—"In the United States, Australia, France, Denmark, Czechoslovakia, India, Burma and Malaya, plans are under discussion or in operation for the wide use of the film of fact for information and instruction".

The truth is, I suspect, that the makers of British documentary films have been pioneering the way into material more difficult than their contemporaries elsewhere have as yet sought to bring to the screen. They are studying and analysing our society and its environment: they are mastering and popularising scientific themes. I wonder occasionally whether, in the ardours of their exploration, our British producers have not sometimes reacted too fiercely against the traditional accents of the BBC; whether, by reason of their interest in social and scientific problems, and their fear of being accused of art for art's sake, they have not cared too little for the quality of the spoken word. Personally I stand fast by that saying of Mill's which I quoted earlier—" It is the artist alone in whose hands truth becomes impressive and a living principle of action". If you asked for examples of that truth in modern films, I should give you two—one British and one American. "Song of Ceylon", a picture of fine lyrical quality, was made about fifteen years ago. It won the Belgian Government's prize in 1935. I had supposed it since outmoded by later films. But I open the American Journal *Time* of January 28th last and I read of " Basil Wright's extraordinarily beautiful ' Song of Ceylon ' . . . The film bears about the same relation to ordinary travelogues that Keats's ' Ode on a Grecian Urn ' bears to a cheap pottery catalogue." The other example, which is never far from my mind, is "The River," that film on soil erosion in the Mississippi valley to which I have already referred. I have heard it criticised and even dismissed as unimportant. But can any sensitive person, who has seen and heard it, ever forget it—ever forget the beautiful and moving voice of its narrator, the poetic quality of its prose?—"We cut the top off the Alleghennies and sent it down the river"; its picture of the poverty of the people—" ill-housed, ill-clad and ill-fed—and in the greatest river valley in the world "; even its roll-call of the cities through which the river passes—" Natchez, New Orleans and St. Louis, Cairo, Memphis and St. Paul."

In pleading for a remembrance of these values, I do not forget the other side of the shield—the intrinsic difficulty of the relationship between the creator and the administrator. It is essential that the administrator should always remember—to apply a witty phrase of Paul Rotha's—that it's films we want, not files; essential also that he should study the delicate art of so handling creatively-minded staff as to give them the fullest possible liberty within the set frame.

But these are no more than passing reflections. The outstanding factor is the growing importance of documentary. This is no place to discuss, in any but a few sentences, why the arts of public interpretation have in the last decade suddenly assumed such importance. There is no need in the closing months of 1946 to stress the extreme need for better understanding between the world's peoples. The opening words of the constitution of UNESCO put it well—" Since wars begin in the minds of men, it is in the minds of men that the defences of peace must be constructed." Within the British Commonwealth the need for better interpretation is surely even more urgent to-day than it appeared to the Empire Marketing Board

when it started its work twenty years ago last May, and is still inadequately faced. Within our own coasts we have to meet the demand for helping a greatly increased electorate to understand what is being done, and what is proposed to be done, in their name and for their benefit by central and local government; to understand, too, the co-operation that is required of them. I am not sure that this need is even now clearly and imaginatively grasped in Whitehall. In local government, if you had met, as I did last Whit Monday, some 700 members of the National Association of Local Government Officers for a discussion of public relations, you would have understood how great was the need and how keen the desire to meet it among those who serve our local authorities. We still have the problem of making the fruits of scientific research more promptly available to those who should profit by them. We have unlimited opportunities of visual education and training. Each of these broad territories could be broken up into many specialised fields. In every one of them the documentary film, so largely independent of differences of language, so compelling to all of us who depend upon the eyes and the imagination, has a unique part to fill.

That great demand, a fraction only of it yet formulated, the documentary film movement is already doing much to meet. I could not give you the complete picture, but here are some examples that I have lately come across. I read the *Monthly Review* issued by the Films Division of the Central Office of Information. It records among recent achievements the success of " Western Approaches " on Broadway, and a forthcoming show of " Children on Trial " to 1,000 representatives of juvenile deliquency organisations in the United States. It refers to the first experimental films made for the Ministry of Education—the forerunners, I hope, of a continuing programme. It shows the Training and Education Division of the Treasury commissioning a couple of " Public Relationship Films " for the benefit of the Civil Service. The Colonial Film Unit is at work in, and for the benefit of, the Colonial Empire.

In the wider field, here is a film—" Personnel Selection "—breaking psychological ground by the depiction of the methods adopted by the War Office for the testing of candidates for promotion. Here is Manchester commissioning Paul Rotha to put on the screen a clear portrait of its civic life. I hear of at least one University that is thinking of having its resources illustrated upon the screen. I was enjoying the other day " The Way We Live", the film in which Miss Jill Craigie has brought alive the reconstruction problems of Plymouth; and I look forward to seeing the film in which Ralph Keene and Lauri Lee, in face of the worst shooting summer in English film history, are to present our National Park problem. Here are Imperial Chemical Industries producing a remarkable series of medical films, among them those admirable films on anæsthesia; producing also, I understand, a series on the factors of soil fertility. Here is the Shell Film Unit, handling in series of films such diverse subjects as the principles of flight and insect pests. Here is the British Gas Council recording the pioneer work of its industry. The Danish Government employs Arthur Elton to build up a unit for its cinematic purposes. The Scientific Film Association compiles, and the Association of Special Libraries publishes, an imposing catalogue of " Films of general scientific interest available in Great Britain".

The programme of production, of which these are little more than random examples, will appeal, if not always to general, certainly to specialised audiences all over the world; and that, to all who believe, as I do, that the exchange of specialised knowledge is one of the most potent instruments of international understanding, is a heartening prospect. But the power and the opportunities of the documentary film are not confined to specialised audiences. Let me give you one glimpse of what they may mean overseas. In the current number of the *Documentary News Letter* a correspondent describes how, in a township twenty-odd miles from Kuala Lumpur, in an amusement park full of other attractions, he watched the eyes of an audience, that numbered 2,000 at the beginning—Chinese, Malays, Tamils, Sikhs and Eurasians—and steadily increased as the show went on, glued for an hour and a half to the screen of a free cinema show organised by the Public Relations Department of Malaya. Does not a glimpse like that add force and poignancy to the hopes, which I voice, and which I am sure that this audience will share with me, for an active development of the British documentary film movement? Does it not make even more fervent the good wishes, in which I know you will join me, to all the makers, inside and outside the public service, of British Documentary Films?

And now you must forgive a final and closing word of reminiscence. Those who had taken part in the work of the E.M.B. between 1926 and 1933 suffered a sharp disappointment when it got a suspended death sentence at Ottawa and was later executed in London. No doubt at Ottawa, as Mr. J. H. Thomas remarked to me at the time, " there were too many fellows hanging about with wreaths." But those who understood at the time what the aims of the E.M.B. were and what it was capable of doing, have at least enjoyed in some measure what that great American, Mr. Justice Holmes, once described as "the subtle rapture of a postponed power". They can see fruits of their work in enterprises as diverse as the Library at the great veterinary Research Station at Onderstepoort near Pretoria and the huge experimental ship's hold at East Malling; as the internationally-controlled Anti-Locust Bureau and Queen Mary's Rose Garden at Regent's Park. Not least among its fruits was the British documentary film movement; and for it, as for so much else, you have to thank in the first place the courage in office of our Chairman of this evening, Mr. Amery.

DISCUSSION

Mr. EDGAR ANSTEY: I should like to speak a few words, if I may, as a member of the British documentary film movement. To all of us here present this is certainly a great occasion, and an extremely moving occasion. I think that that is so for two reasons. First, because we have heard the history of the documentary film movement told with an eloquence and an insight quite unmatched in my experience. Attempts have been made by many of us to tell this same story, but never have I heard it told so well. The second reason is,that we have been hearing the story from someone without whom the documentary film movement in this country would never have existed. Probably all of you here are conscious of that, but Sir Stephen speaks with such modesty that the point might be missed. Many of the crucial episodes which he has described in the history of the documentary film would have had a different outcome had he not been in his official post to see us through.

Of the documentary film makers who could not be present tonight, it is perhaps not irrelevant to tell you why two are absent, because I think that it has a connection with our story. John Grierson and Basil Wright are at the moment in Paris at the UNESCO

Conference, to which many of us are going tomorrow and on Friday. Both of them, I think, did make very special efforts to be here. Grierson was over from New York in Europe for a few days only. I think that Sir Stephen will feel that although they could not be with us to-night, their time could not be better occupied than in Paris, contributing what they can to the deliberations of the UNESCO Conference.

I think that I speak for those other documentary film makers who are present, when I say that we wish that we could have deserved the praise which we have heard from Sir Stephen, and the importance which he has attached to our work.

Sir DRUMMOND SHIELS: Having shared in the work of the Empire Marketing Board, I should like to associate myself with the tribute which Sir Stephen has paid to the Chairman for the great things which he did then, and for the encouragement and inspiration he afforded to those who worked in that remarkable organisation. It is true, as Sir Stephen has hinted, that there was some mystery about how it came to a premature, end, because no one seemed to be responsible, and everyone appeared to regret that it was going or had gone; but there is no doubt that it was most unfortunate that it was not continued. While it lasted it did a tremendous amount of good. Those of us who were privileged to take some small part in it will be very glad of such an opportunity as this to say what an inspiration Sir Stephen was as Secretary, and how he stimulated and helped not only the documentary film work of which he has spoken, but also every department, Research Grants, for example, and others.

I should like to say how much I agree with what Sir Stephen has said about the effect of the kind of documentary film which shows the work of a class of people who are not very well known to the public, or at any rate whose labours are not seen by the public. It is particularly true with respect to the psychological effect on the workers of knowing that their work is recognised as important, and that they have the prestige and the status which means so much to every worker.

In the colonial field also, how important is the kind of thing that he mentioned which took place in Malaya, namely, thousands of people watching the screen from both sides in the open air in the darkness. In view of the widespread illiteracy in the Colonial Empire, only now being tackled on a large scale, and the importance of adult education, we cannot put too much stress on the educational value of the documentary film in this field.

Mr. E. W. M. HEDDLE: I have listened to Sir Stephen with very great interest indeed, and I would reiterate the words of the first speaker. My main interest in films has been in the organisation of what is called the London Films School, which takes place during the Summer Vacation in the University of London. There we have been able to come in contact with some of the principals in documentary films, and out of some two dozen speakers this summer only two disappointed us. The evenings in the Summer School were spent in reviewing the documentaries in the film studio of the Ministry of Information building, which we took over from them at that time.

Several people have asked how it is possible to see documentaries, because they are not shown in the ordinary cinema. The main opportunities lie with Film Societies. Recently Dr. Mallon, who is a Governor of the B.B.C., Warden of Toynbee Hall, and Chairman of the Governors of the People's Palace, has arranged for a showing of what he calls "Great Films of the World" in the People's Palace on Sunday nights. Each evening a different country is represented. Some weeks ago we had Great Britain represented by a number of documentaries, including "World of Plenty", and Paul Rotha himself came along to give an introduction to the film and to say something about its method of showing.

Those evenings are so popular that we get an average attendance of about 1,600, and Dr. Mallon and John Maddison, who is writing little notes to help out the programme, are arranging for a continuous series. They are going on until the end of the year, and in January as well. In that way by taking different countries of the world it is possible to compare the British documentary with that of some of the other countries. For instance, for Switzerland they showed the film, "Marie Louise", which dealt with the evacuation

of children from French towns to Switzerland, where they were kept for a period of three months and then returned again. The psychological effect on the child is very marked throughout the whole of the film, and the treatment of it is totally different from what they develop in this country.

Sir HARRY LINDSAY K.C.I.E., C.B.E. (Director of the Imperial Institute) First of all I would like to thank Sir Stephen very much indeed for his kindly references to the Imperial Institute, and to the home that we were able to give to the Empire Film Library. I would add that that library, although it is housed with the Central Film Library and under its friendly ægis, has also an existence of its own and is being added to steadily from the overseas Empire. We receive particular help from Canada and great help also from India and from the other Dominions and Colonies.

I would like to say a few words about the film which Sir Stephen himself mentioned during his talk, "The Song of Ceylon". That film is still going as strongly as it was on the day when it was first issued, and it is still attracting as much admiration. The secret seems to have been that the artist was able to sink himself in his subject. In this connection Sir Stephen made a very moving and affectionate reference to Mr. Rudyard Kipling. The art is really the same in both cases, for the short story as for the documentary film. The artist is one who loses his heart, so to speak, to his subject. You cannot get an expert becoming an artist for the purpose of preparing a documentary film. You must do it the other way round. The artist must himself for the time become the expert, and "Song of Ceylon" is a film in the making of which Basil Wright definitely did lose his heart to his subject. I think that it is the finest film, as a description of the Oriental mind and life, that I have ever seen. We have quite a number of films of Oriental subjects, and the "Song of Ceylon" is, I think, outstanding amongst them all.

THE CHAIRMAN: I am sure that we are all immensely grateful to Sir Stephen for his lecture. I was particularly happy to be brought back in memory to those great days in the distance enchanted when it was really fun to be alive and to feel that one was doing creative work with a band of enthusiastic fellow workers: men in politics on every side, Civil Servants, artists, and all the miscellaneous band whom Sir Stephen gathered around him. My own part was, I think, largely confined to giving Sir Stephen his head. I daresay that I sometimes contributed an idea, and before next morning it had become a plan, and before many weeks were over it became a reality. Those were great days, and I still regret that that immensely interesting experiment, affecting not only Empire relations, but almost every phase in life, was cut short because the Treasury felt that after Ottowa, when some preference had been granted, the original reason had ceased, and the project was abandoned. It was, I think, a very short-sighted decision. However, much of the work which was done has lived on, and has indeed grown mightily since.

What struck me on the whole subject of the documentary film was that it is so often said that our modern life is drab, and that to-day especially it is a life of frustration. That is only because we look at it with the wrong eyes. Kipling saw that when he made modern things part of the romance of poetry. You will remember poems like "Farewell Romance . . ." and "I sent a message to my dear . . ." or "M'Andrew's Hymn". The documentary film has done that in large measure for the ordinary man about his own ordinary life. It is not that romance is not here, but that the unseeing eye cannot discover it. If you show a beautiful picture to a savage he sees nothing but blobs of colour. He is not even sure which way up the picture is. The eye has to be trained. What the documentary film has done very largely is to train the eye of people to the romance in their own lives and in the lives of their fellow men, in whom they have not taken much interest before. It has had a wonderful effect in bringing not only parts of the Empire, but our own fellow citizens at home, closer together by making us understand each other's lives; and when our own lives come into the picture, we are interested and proud to discover that those lives have an interest and an attraction for other people.

If I may go by my own very slight knowledge of these things, I think, too, that the documentary film has had a very good effect on the purely romantic film by clothing

what was, to begin with, a mere method of escape into unreality with some of the flesh and blood of real life.

Sir Stephen referred as an example to the film, "In Which We Serve", where you had a thrilling story, but it was in all its technique essentially a documentary film. There was nothing unreal and nothing to jar on the minds of those who knew something about the Navy. For those reasons one hopes that the documentary film, and the British documentary film in particular, will go on developing and exercising its influence, both on our national and Empire life, and on our conception of life as a whole.

Sir EDWARD CROWE, K.C.M.G.: Before we break up I think that you would all like to pass a very hearty vote of thanks to Mr. Amery for coming here to night and for presiding so gracefully. There are present many members of that splendid institution, the Empire Marketing Board, and we remember what a tower of strength he was. You have heard from Sir Stephen how Mr. Amery presided at the historic meeting when my old chief, Mr. Arthur Michael Samuel, who was then representing the Treasury, was persuaded to support the idea of films. If Mr. Amery had not been in the chair on that occasion it is very probable that the production of documentary films in this country might have been long delayed. It is no exaggeration therefore to salute him as the father of the documentary film. But that of course is only one of his minor claims to fame.

To all of us in this Society Mr. Amery represents what we mean when we say that a man is Empire-minded. No living English statesman has done more for the Empire than Mr. Amery, and it is for that reason that I ask you to thank him not only for sparing the time to come and preside over our meeting but for what he did for the Empire Marketing Board in the good old days, and for his devotion to the cause of Empire.

The vote of thanks was carried with acclamation and the meeting then terminated.

GENERAL NOTES

THE COLOMBO CATHEDRAL COMPETITION.—The 31st December, 1946, is the closing date for the entry of designs for the Colombo New Cathedral, in the competition which the Royal Society of Arts has undertaken to organise.

As Fellows of the Society are already aware, the Council in November, 1944, received a letter from the Bishop of Colombo, who, as Chairman of the Colombo New Cathedral Committee, invited the Royal Society of Arts to act as the agent in London for his Committee in organising a competition for a design for the projected Cathedral. The choice of an Assessor (Sir Giles Gilbert Scott, O.M., R.A., PP.R.I.B.A.), and other matters connected with the competition, had been arranged with the R.I.B.A. by the Bishop of Colombo while on a visit to England, but it was still necessary to find a Society of standing to act for the Committee in Britain, and sponsor the competition.

The Council agreed to this request. It was further arranged that the competition should be administered by the Committee of the Dominions and Colonies Section of the Society (Chairman, Sir Harry Lindsay).

During that winter (1944–45) the details of the arrangements were discussed with the Bishop of Colombo and the New Cathedral Committee. The conditions of the competition were drawn up, and site plans printed for competitors. Eventually 250 copies of these were printed to meet all probable demands. During the summer of 1945 advertisements were inserted in architectural journals in the United Kingdom and in the Overseas Empire. In not a few cases these journals gave the Society editorial support by notices in their columns, often inserted when the paid advertisements could not be displayed for lack of space. Among the editors who gave the courtesy of their columns to the announcement were those of the *Journal of the Royal Institute of British Architects*, the *Official Builder*, the *Journal of the Royal Architectural Institute of Canada*, and the *Journal of the Indian Institute of Architects*. The New Zealand Institute of Architects

embodied the invitation to compete in a circular sent to all its members. Advertisements were also printed in leading newspapers in the other Dominions and in the Colonies.

The premiums for the best designs have been fixed at £500, £200 and £100, and it was announced, in the absence of any valid objection, that the winner of the first premium should be employed to carry out the design at professional charges. It was proclaimed that "it is the intention of the Promoters to proceed with the Scheme as soon as the international situation permits".

In accordance with the estimate of time required to advertise, send out conditions, receive inquiries, answer them, and allow the competitors to produce a design, the closing date for entries was fixed at December 31st, 1946; the last day for withdrawals September 30th, 1946; and the last date for competitors to send in questions, February 28th, 1946. The questions were submitted to the Assessor, and these were collected together and formed into a "Questions and Answers" memorandum which was forwarded to all competitors.

The number of applications for conditions received totalled 223, and of these 42 were subsequently withdrawn. Of the remainder, 135 entries are from the United Kingdom, and 41 from the Overseas Empire, including Eire; three members of the Services, serving afloat or abroad, are competitors. Ten of the Empire entries are from Ceylon. Others have come (in order of number of entries) from India, South Africa, Australia, Eire, New Zealand, Canada, Palestine, Malta and the Seychelles.

When the winning designs have been chosen, the Royal Society of Arts will arrange for all the designs which were accepted for adjudication to be exhibited.

Designs are now being received ; and it is hoped that these will contain a design which will be deemed worthy of the new Cathedral, and will vindicate the faith and perseverance of the promoters in face of war-time difficulties and uncertainties.

MAX BEERBOHM'S CARICATURES.—On his seventieth birthday Sir Max Beerbohm enchantingly addressed the Maximilian Society in a little speech which has not, I think, been published. Referring to his caricatures, he told us that in his youth he had carried away grotesque impressions of the Olympians he had met, so later recorded those grotesques. Years later he had found that the impressions his contemporaries imprinted on his memory were always as they actually appeared, so that he had to exaggerate their features afterwards—mistakenly in his opinion.

Very rarely does Max draw from life, and "seldom"—as Bohan Lynch has remarked —"are the results satisfactory when he does". In this he resembles Pellegrini, who made his caricatures from memory, and Constantin Guys who stored his mind with impressions of the glittering life of the Second Empire and evolved a highly individual style in recording them. Max's own formula is so distinctive that his caricatures, very often in line and wash with some words of gentle irony, can be recognised at a glance as "Max cartoons", though it must be admitted that some of his early work is extremely tentative. Very often he found difficulty in hitting on a formula, and William Rothenstein has recalled how he once offered to assist the young artist's memory by lending him one of his own lithographs of a subject—but "No thanks, dear Will", replied Max, "I never work from photographs".

Most readers must have come across, at one time or another, the grotesque groups of forty or fifty years ago of which the assembly of elders of the New English Art Club and "Some Persons of the Nineties" are typical. In these may be seen Max's characteristic devices, accentuated at that period but modified in later years, of shapeless boots and needle-sharp feet to distinguish the Bohemian or rustic from the urbane type, elongated necks and exaggerated hair, and the outstretched arm and huge fist of the energetic man—a mannerism he gradually abandoned.

Many of his caricatures of the 'nineties—such as the India ink sketch of Lord Spencer, formerly in the Guedalla collection, which lies before me—are of the hit-or-miss order —*jeux d'esprit* that Max either brought off triumphantly, or which reveal only too clearly a lack of inspiration and an untrained hand.

But his assurance increased with the years; and from the Edwardian period onwards —in the long line of exhibitions held at the Leicester Galleries and a few choice volumes of caricatures, such as "Things New and Old" and "Observations"—those discerning folk, who admire Max as much in line as in print, have enjoyed at intervals his little masterpieces of irony, caricatures whose contours are drawn with several strokes of the pencil, treated with pale washes of colour and inscribed with a line or more of urbane satire.

The foregoing remarks have been prompted by a recent visit to the Ashmolean to see the group of caricatures, from all periods of Max's career, lately bequeathed to the museum from the Philip Guedalla collection.

The Royal Society of Arts was honoured by the last address delivered by that brilliant historian before his untimely death, and it is of interest to recall that he was the most notable collector of the caricatures of Max Beerbohm, with whom he enjoyed a lively correspondence. Indeed, all who were privileged to meet Guedalla in his house in Hyde Park Street cannot fail to remember the caricatures which extended up the staircase, in serried rows along the landing to the drawing-room, and further still. "One goes upstairs grotesquely attended by them" wrote Edmund Gosse to Max after dining at the house.

And how easily one can imagine Gosse's gleaming spectacles focussed benignly on the huge grey figure of Henry James, adrift in a London fog and intent on studying his hand—one of the choicest drawings from the Guedalla collection, which lately filled the rooms of the Leicester Galleries. Entitled "London in November, and Mr. Henry James in London", the caption reads: "It was therefore, not without something of a shock that he, in this, to him, so very congenial atmosphere, now perceived that a vision of the hand which he had, at a venture, held up within an inch or so of his face, was with an almost awful clarity, being adumbrated."

How easy, too, it is to picture Chesterton quivering convulsively before titanic eruption at the mischievous representation of himself seated at dinner. There is a vast crumpled expanse of dress shirt, and between groaning waistcoat and resigned trousers appear the braces, strained to their uttermost.

These are mockeries that disarm criticism. Their victims cannot protest because they are too helplessly convulsed. Like Max himself, when (as acquaintances of Enoch Soames will recall) he was surprised by the Devil in a Soho restaurant, they rock to and fro, and lie back aching. "Don't", they gasp faintly. "Oh. don't!"

N. A. D. W.

NOTES ON BOOKS

LEWIS'S 1844–1944. H. K. Lewis & Co., Ltd.

To the ordinary man in the street the word "Lewis's" does not signify much, but in the world of medicine no name is more familiar. This little book, excellently turned out with many interesting photographs, gives a brief account of the century's work completed by the firm—Henry King Lewis, after serving an apprenticeship in a small bookselling, newspaper and printing business in Windsor, came up to London and at the age of 22 purchased a similar bookselling and stationery business in what was then 15 Gower Street North. Before the transfer was completed the owner agreed that Mr. Lewis should visit the shop to judge of the character of the business. A young lady came in and bought a two-guinea writing desk. Some time afterwards it was discovered that the "sale" had been arranged to impress the prospective buyer. In the hands of Lewis, however, the business rapidly developed so much that there was no further need for bogus purchasers. He had chosen his position wisely, for it was close to the University of London, now University College, which soon became a valuable customer. The book records that readers of the *Lancet* who did not wish to keep it, passed their copies back to Mr. Lewis to find a "Second Reader." The first reader paid rather more than half the subscription, and the second paid the balance. The display

in the window of a notice " Second-reading of the *Lancet* to let," usually found a ready applicant ; but the custom died out a good many years ago.

Lewis was a keen chapelgoer, and the first books which he published were of a religious nature, but he soon turned to the line which has made the firm famous. A very long list of medical works—many of them destined to become classics—issued from his house, and nearly all the great names in British medicine and surgery appeared in his catalogues. Two pictures may be taken as symbolic of the rise and expansion of the firm : the modest little house in Gower Street where " Lewis's " started, and the imposing building on the same site which forms the frontispiece of the present volume.

G. K. M.

THE ARTS, No. 1. Percy Lund Humphries. 1946. 10s.

It is refreshing to find at last an English publication devoted to the arts, with a standard of typography and production comparable with French and Swiss contemporaries. This is not to say that *The Arts* attempts closely to emulate its Continental counterpart. What it lacks in French vivacity and lightness of touch it makes up in sober and serious contents and a sobriety of book production which is thoroughly English, but not a whit less attractive for that. And fortunately it is without that typographical eccentricity which makes the recently published *Contact* quite unreadable, equally with that architectural periodical which, it has been said, everybody sees and nobody reads. The cover design for the first number is by John Tunnard, who is perhaps the best English abstract artist. So much for the general appearance.

The articles are for the most part written by recognised authorities, and if they vary considerably in importance, they are at all events chosen with catholicity. Dr. Herbert Read writes an introduction to the work of Edouard Pignon, which though tolerably interesting on existentialism, social realism and so on, adds very little to one's appreciation of the artist, on whom the editors have lavished two full-page colour plates and ten half-tone reproductions with unmerited generosity. To my mind the English artist Gerald Wilde has greater force than Pignon in this genre, and perhaps in subsequent numbers Dr. Read will not overlook him.

Sir Kenneth Clark's contribution on Architectural Backgrounds in XVth Century Italian Paintings is a model of scholarship disguised in prose of admirable lucidity and charm, and splendidly illustrated with reproductions of works by Ghiberti, Donatello, Boticelli, and others.

There follow articles on the British Film by Richard Winnington, reasoned, intelligent and hopeful this ; and notes on a new figure by Henry Moore, by Edward Sackville-West. The photographs are excellent and illustrate the progress of the figure from wood block to completion. This figure will not surprise admirers of Mr. Moore's carving, except perhaps for a sort of spherical and valved heart which occupies the customary hole beneath the breasts—a hole which has caused more excitement among " advanced " critics than any event since the post-impressionist exhibition in London in 1910. Earlier on, Dr. Read refers to Mr. Moore as a socially *engagé* artist. This work certainly does not fall within the meaning of the term as I understand it, but perhaps Dr. Read refers to Mr. Moore's shelter drawings and the *Northampton Madonna* which I have the temerity to think finer works and which have the additional virtue of social intelligibility.

The Arts also contains a long poem, *Europa and the Bull*, by W. R. Rodgers, illustrated by Duncan Grant, an essay on modern architecture, accounts of Benjamin Britten's two operas, the performance of *Peter Grimes* in Stockholm and the *Rape of Lucretia* now at Glyndbourne. The two final contributions I find the most satisfactory of them all ; the first by Raymond Mortimer on " The Desirable Life," because he has the courage to adopt a literary approach to his illustrations, and to defend his choice with a sensitive commentary on the excellently chosen pictures which range from Claude to Dégas ; the second, an acutely intelligent dialogue by Lawrence Gowing entitled *Painter and Apple*, because so much can be learned from the practising artist that no critic can tell us.

With such a range of contents it would perhaps be churlish to jib at the price of ten shillings.

LEONARD GREAVES.

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4734 *FRIDAY, JANUARY 3rd, 1947* Vol. xcv

MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

Dr. Mann Juvenile Lecture

Wednesday, January 8th, at 2.30 p.m.—"The Story of Glass". By J. H. Partridge, B.Sc., Ph.D., of the Research Laboratories, General Electric Co., Ltd. (Illustrated by a sound film and demonstrations).

Admission to this lecture is by special ticket only, as already announced.

Ordinary Meeting

Wednesday, January 15th, at 5 p.m.—"Great Britain in Relation to the World's Trade Situation." By Sir Charles Lidbury, Chief General Manager, Westminster Bank, Ltd. The Right Hon. Viscount Bennett, K.C., P.C., LL.D., President of the Society, will preside. (See notice of "Lectures on Economic Reconstruction" below).

India and Burma Section

Thursday, January 16th, at 2.30 p.m.—"The Doon School". By A. E. Foot, Headmaster, The Doon School, India. (Read by J. R. Rahim, in the absence of the author). Sir Harry Haig, K.C.S.I., C.I.E., will preside. (Illustrated by lantern slides). Joint meeting with the East India Association.

LECTURES ON ECONOMIC RECONSTRUCTION

The first of this series of lectures will be given on January 15th, as reported above. The other papers are arranged as follows:

January 29th.—"Scientific Approach to Labour Problems". By Walter C. Puckey, M.I.P.E., Director and Works Manager, Messrs. Hoover, Ltd. The Right Hon. Lord Citrine, P.C., K.B.E., will preside.

February 12th.—"Materials". By F. A. Freeth, O.B.E., D.Sc., Ph.D., F.R.S., of Imperial Chemical Industries, Ltd. The Right Hon. John Wilmot, M.P., Minister of Supply, will preside.

February 26th.—"Finance and the Use of Money". By A. H. Ensor, Chief General Manager of Lloyds Bank, Ltd. The Right Hon. Lord Kennett, P.C., G.B.E., D.S.O., will preside.

MARCH 12TH.—"CRAFTSMANSHIP". By Reco Capey, R.D.I.

APRIL 16TH.—"PRODUCTION". By the Right Hon. Oliver Lyttelton, D.S.O., M.C., M.P. Sir John W. Gibson, O.B.E., Deputy Director-General Civil Engineering (Special), Ministry of Supply, will preside.

APRIL 30TH.—"DISTRIBUTION". By E. J. B. Lloyd, B.A., LL.B., Director and Secretary, Lewis's Investment Trust, Ltd. The Right Hon. Lord Woolton, P.C., C.H., will preside.

MAY 14TH.—"BRITAIN'S ECONOMIC FUTURE". By Alfred C. Bossom, F.R.I.B.A., M.P. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Society, will preside.

SUPERSONIC VIBRATIONS AND THEIR APPLICATIONS

By E. G. RICHARDSON, B.A., PH.D., D.SC.
Reader in Physics, University of Durham

CANTOR LECTURES

LECTURE I.—*Delivered November 11th, 1946*

The vibrations which I am going to discuss are those which, though of the same physical characteristics as sounds, have frequencies so high that they fall outside the range of pitch to which the human ear is susceptible. It is well-known that as the pitch of a sound goes up it eventually becomes inaudible when its frequency is about 20,000 vibrations per second. Thus, the whole of the supersonic gamut is composed of vibrations whose existence can only be established by their effect on special instruments. There is no theoretical upper limit to the supersonic frequency, though with existing means of production experiments are limited to the range 20,000 cycles to 5 million cycles (20 kilocycles to 5 megacycles) per second.

One's own limitations in pitch range may be tested by means of the Galton whistle, which consists in effect of a little organ pipe. In this a column of air is set into vibration by a jet of wind which impinges on the round lower edge of the metal column which contains it. A screw moves a piston within the pipe itself, thus altering its sounding length. As one mounts the scale of pitch, the sound suddenly ceases at a certain point though air is still leaving the nozzle. The instrument thereafter produces supersonic vibrations. The instrument is graduated in terms of frequency of note emitted. An idea of the size of the instrument can be gauged from the fact that a " stopped " organ pipe to elicit a note of 20,000 cycles/sec. in air requires to be only four and a quarter millimetres long.

It is only within the past thirty years that supersonics have been capable of production in such power and at sufficiently controllable frequencies that they could be used for scientific experiments. Since then they have been put to a number of uses, both in pure and applied science, an outline of which I shall endeavour to give.

The first method of producing supersonics in air or in a gas is based on the Galton whistle itself, and differs from it mainly in the greater velocity of air jet employed,

whereby the energy of the output is much increased. If the velocity of the jet is increased above that of sound in air, a series of shock waves originate at the edges of the nozzle and are reflected to and fro on the confines of the jet, giving a criss-cross appearance. The compression of the air along these wave-fronts is so intense that they can cast shadows on a photographic plate in the same way that the fronts of the shock-waves from bullets can be photographed. Fig. 1 shows the appearance of such a jet. The places where the shock waves are reflected at the barrier between the fast-moving air and the static air outside are evidently zones of considerable instability, since if the mouth of the little pipe is placed there, its natural tone is excited with considerable vehemence. It is, thus, only necessary to have a series of little bottle-shaped resonators from 4 mm. in length downwards or a single one with

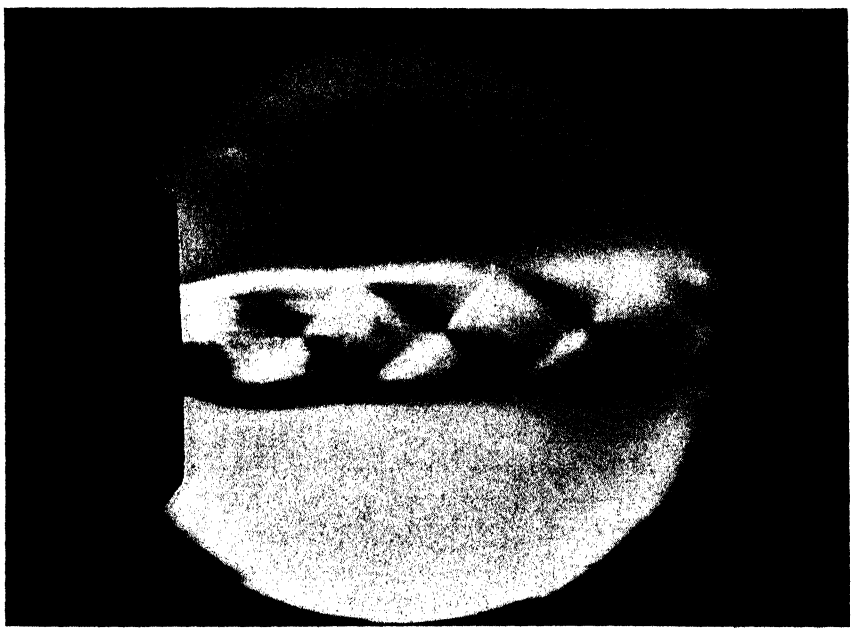


FIG. 1.—*Supersonic waves in a high-velocity jet*

a movable stopper, to be able to excite the neighbouring air into supersonic vibration at a frequency approximately known but, unfortunately, inconstant, since it varies with slight changes in the blowing pressure.

This Hartmann oscillator is useful where one requires a powerful source of supersonics in air and is not concerned to have a precise frequency, but most of the applications to which I shall refer make use of sources working on the piezo-electric or the magneto-striction principle. The former is an adaptation of an effect discovered by the brothers Curie, *viz.*, that certain crystals, when compressed along one of their axes, develop charges on certain faces; and, conversely, that if charges are developed on the faces of the crystals, they suffer deformation. If now an alternating potential difference is applied across one pair of faces, compressions and expansions of the crystal follow at the same frequency. The effect will be most

manifest when the exciting frequency corresponds to one of the natural frequencies of vibration of the crystal, determined by its length in the particular direction of expansion and contraction, and the velocity of sound in the material. Such a piezo-electric resonator was first realised by Langevin in 1917; he used slabs of quartz and applied the necessary potential difference through a thermionic valve oscillator.

The substances most commonly used as sources in this way are quartz, Rochelle salt and tourmaline. They are cut into discs or slabs in such directions that electrodes may be applied to carry potential in the direction of one of their crystalline axes. In the case of the slabs, the electrodes are cemented to the top and bottom and the extensions and contractions take place along the greatest dimension. The discs are usually cut so that the motion takes place in the same direction as the applied alternating potential, namely, perpendicular to the flat face in concertina fashion. The natural frequency is inversely as the thickness of the disc., about 2.5 cm. for 100 kilocycles/sec. and 2.5 mm. for 1 megacycle/sec. in quartz.

The magneto-striction oscillation is induced by a current of the requisite frequency

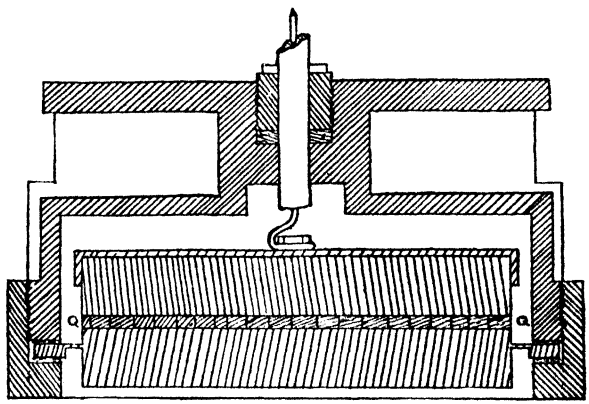


FIG. 2.—*Langevin sandwich*

through a coil wrapped round an iron or nickel rod, causing variations in length as the magnetic field strength alternates.

Either of these latter types of source is capable of sending out into the fluid medium in which it is placed, supersonic waves of sufficient energy for most laboratory experiments. In certain applications, however, a larger radiating surface is required than can be obtained from the face of a single crystal or nickel rod. In order to do this, Langevin constructed a sort of sandwich consisting of a large number of little slabs (QQ, Fig. 2), side-by-side and all having their axes of vibration parallel, between two metal slabs to act as electrodes. By the concourse of crystals vibrating together, the lower plate was made to move relative to the top one in concertina fashion, and thus a large radiating area was added to the source, when working into water.

In the case of the magneto-striction oscillators a number of rings threaded together have coils wrapped round them so that they all expand and contract round their circumferences in unison. The energy is received on the surface of a metal horn,

so that the radial oscillations are turned through a right angle and sent out from the horn in the form of a beam. (Fig. 3.)

Since supersonic waves are inaudible, the question next arises, how can their existence be detected or their amplitude measured? Most of the instruments which are employed on sonic vibrations can also be used for supersonics. There is, for example, a familiar apparatus known to physicists as Kundt's tube, in which sound waves are sent from a vibrating rod or loudspeaker diaphragm along a pipe and reflected at the far end at a hard piston whose position is adjusted until the air column is in resonance. When this state of affairs is secured, the nodes and antinodes set up in the column may be shown by light dust strewn along the floor of the tube, the dust collecting into heaps at the nodes. In like manner if an oscillating quartz is

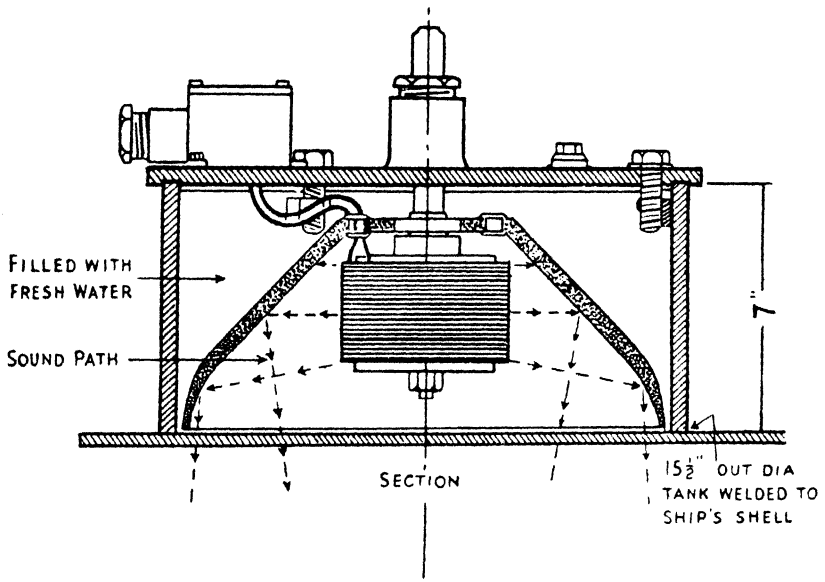


FIG. 3.—*Hughes type of magneto-striction oscillator and transmitter*

set to face a reflector in the form of a flat surface, the existence of supersonic nodes and antinodes may be demonstrated, either by dust particles in the space between, or by the cooling of an electrically heated wire moved through the air between source and reflector. (Fig. 4.) As the wire is traversed along, it is cooled more in the antinodes where there is much movement, than in the nodes where the air is still. If the temperature of the wire is measured, it exhibits a series of peaks and troughs as it is traversed. Using an apparatus like that in Fig. 4, I have measured the velocity and absorption of supersonics in a number of gases and liquids.

An even simpler method of exhibiting the reflection of supersonics from a barrier is afforded by the reaction on the source and its maintaining circuit of the vibrations when they return. When stationary waves are set up between the quartz and the reflector, the air space is in resonance with the source, which will be more rapidly denuded of energy, in the same way as a tuning fork which is mounted on a resonance box loses energy more rapidly than when it is not so loaded. This reaction

on the quartz may be seen on the current meter in the valve circuit, which maintains the quartz in oscillation. The plate current of the valve suffers a series of maxima and minima as the reflector is moved. From the positions of the reflector which produce the maxima the wave-length of the supersonics may be calculated and hence their velocity, and from the relative size of the peaks, an indication of the absorption of the radiation in the medium can be obtained. This apparatus, known as a supersonic interferometer, has been much used in recent years to study the propagation of supersonics in gases and liquids.

Certain peculiar features of the propagation of supersonics became apparent as soon as measurements were made on certain gases, of which carbon dioxide and nitrous oxide are salient examples. It is well-known that the velocity of sound in air and all other gases is independent of frequency in the audible range. If it were not so, a piece of music played by a band would be unrecognisable at a distance.

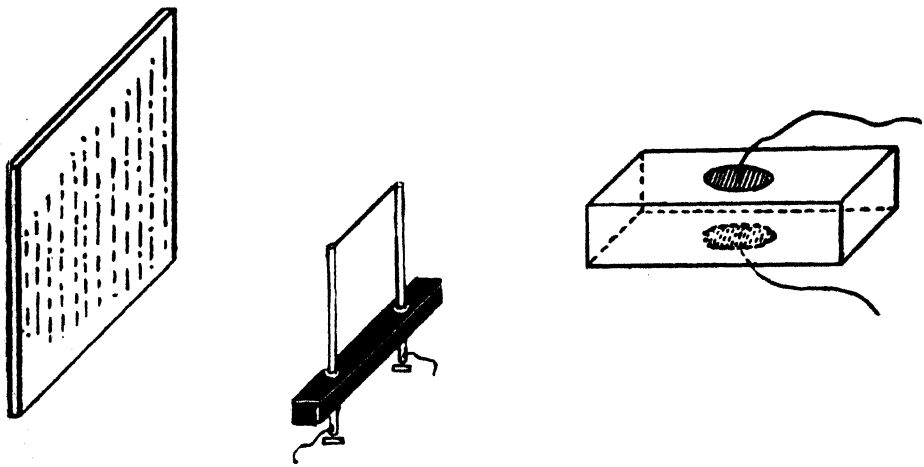


FIG. 4.—*System for observing supersonic stationary waves. Piezo-electric source, hot-wire detector and plane reflector*

In carbon dioxide and nitrous oxide at a frequency near 100 kilocycles per second a sharp rise of velocity from 258 to 270 metres per second is encountered, with a more gradual fall beyond. In the same region an absorption of the radiation many times greater than in a normal gas, such as argon or oxygen, makes detection of the radiation and the measurement of its velocity by the usual apparatus a matter of some difficulty beyond an inch or so from the crystal face. Fig. 5 shows such results in CO_2 (circles), N_2O (crosses), O_2 (stars) and Ar (dots). This peculiarity has not yet received a complete explanation. The excessive absorption may indicate some resonance in the gas at this frequency, and such behaviour would be borne out by the sharp rise in velocity. Whenever excessive absorption accompanies resonance in a medium, it becomes difficult to detect the radiation except in the immediate neighbourhood of the source. Another function of such a system is to scatter the radiation—that is to say, that each oscillator in responding sends out new waves in all directions, irrespective of the direction from which the energy reached it.

This too has been shown to happen in carbon dioxide at the critical frequency, whereas in oxygen a beam of supersonics directed through the gas remains a beam without dispersion during its passage.

Although scattering of the supersonics points to resonance of some kind in the gas, there is another explanation which some prefer. This theory regards the process of the passing of vibrations from particle to particle in a gas (so that a wave is propagated) as being carried out by a series of strains and relaxations, rather like the pushing open of a swing-gate and its subsequent release by a number of persons in a hiking club. If the frequency—that is, in our humble analogy, the rapidity with which the walkers follow each other through the gate—becomes too great, the molecules remain permanently taut—the gate stays open without swinging back until all are through. Thus, when the period of the oncoming waves becomes equal to the

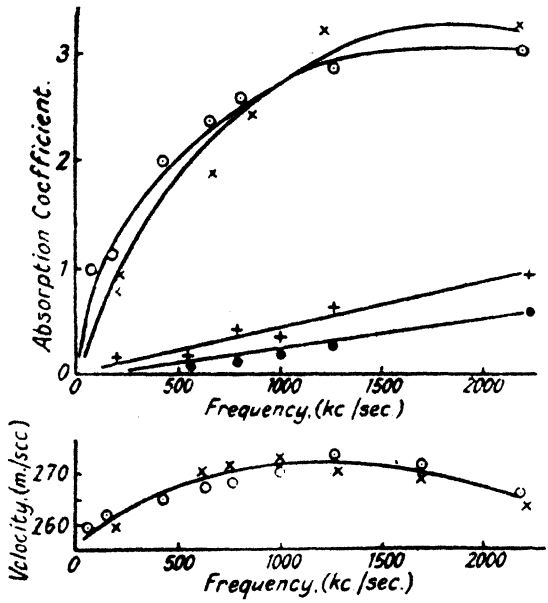
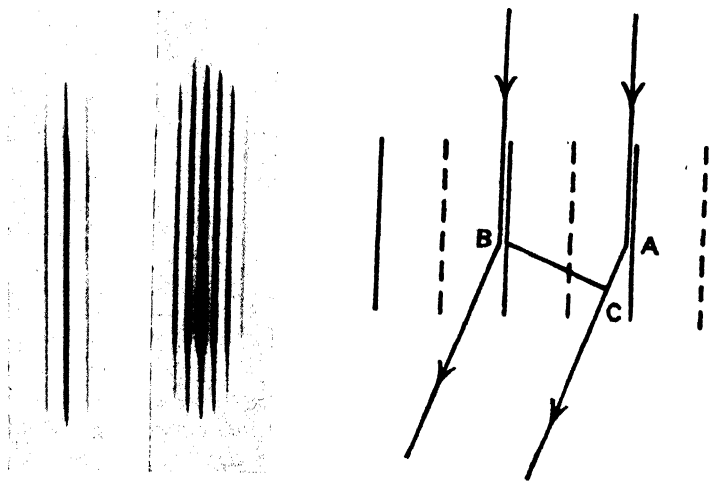


FIG. 5.—*Absorption and dispersion of velocity in gases*
(*Carbon dioxide* o o o ; *nitrous oxide* × × × ; *oxygen* + + + ; *argon* . . .)

time of relaxation of the molecule, they not only pass through faster, but in doing so do not set the gate—we should have said, the molecule—in oscillation. It is not supposed that all the molecules in a gas have exactly the same period of relaxation, otherwise the passage of the supersonics would be suddenly affected at the corresponding frequency, but that they average round the period corresponding to the excessive absorption. The velocity rises at the same time as the energy passes rapidly over the unresponsive molecules. Whichever explanation is ultimately accepted, the experiments point to a molecular manifestation quite unexpected before the advent of supersonics.

Another method of studying the propagation of supersonics is based on the discovery that the series of compressions and rarefactions which constitute super-

sonic waves in a liquid can act as a grating to light and cause optical diffraction. The fact that the whole "grating" is travelling across the field of view at the speed of sound does not affect the phenomenon, since this speed is negligible compared with the speed of light. In practice, the light beam is sent through the glass tank containing the liquid at right angles to the direction of propagation of the supersonic vibrations, and when the supersonic source is passive, it gives a single line in the field of view of a telescope sighted through the glass. When the supersonic source is turned on to form the grating, the emergent light beam is seen to be accompanied by diffraction bands on either side (Fig. 6 (*a*), (*b*)). From the spacing of these bands, the supersonic wave-length in the liquid can be deduced as in the corresponding case of the diffraction of X-rays by a crystal. In Fig. 6 (*c*) the straight and dotted lines represent the zones of maximum and minimum pressure, the "peaks" and "troughs" of the waves. These scatter the light passing parallel to them.



(*a*) (*b*) (*c*)

FIG. 6.—*Diffraction of light from a slit by a supersonic beam*

When AC, Fig. 6 (*c*), is a whole number of wavelengths, a diffraction maximum is obtained.

When a quartz is set in oscillation in a liquid, considerably more electrical energy has to be supplied to maintain it than in a gas, owing to the much heavier load presented by the denser medium. It is to be expected that not only will the liquid damp the vibrations of the quartz, but the supersonic radiation will be dissipated in the liquid itself more rapidly. Although in water and aqueous solutions supersonics show a fair amount of absorption, it is not excessive as compared with that of audible sound in the same substances. If it were, it would not be feasible to use these radiations in place of low-frequency ones for submarine signalling and sounding. But just as certain gases display a disproportionate consumption of the vibrational energy traversing them, so some organic liquids rapidly disperse the supersonic beam which passes through them. Benzene and chloroform are examples

of liquids which show this propensity to a high degree. Since, again, these are substances which are notorious for the amount of light they scatter when a luminous beam is directed athwart them, it is believed that a similar process is at work, and that there is a tendency inherent in these fluids which endows them with a behaviour characteristic of a heterogeneous mass like that which we attribute to colloids such as smoke and oil-paint. Water is homogeneous in the sense that the particles responsible for the process by which light and sound are dispersed are minute in size, are, in fact, molecules; whereas those of carbon dioxide and benzene must combine to form larger aggregates, presenting a " speckled " effect to the oncoming radiation.

A change of velocity with frequency such as was found in gases yet awaits confirmation in any liquids, so that if the particles possess a time of relaxation, it must be short compared with the range of periods of vibration so far employed.

A peculiar state of affairs exists in liquid helium, to which attention has recently been drawn. No marked change in the velocity of sound with frequency has been reported, but, whereas in an ordinary fluid, waves of temperature, if set up for example by supplying alternating current of high frequency to a platinum strip in the medium, are propagated at a low velocity compared with that of compressional waves, in this liquid of abnormal heat conductivity, thermal waves travel nearly as fast as sound waves and are appreciable to the same distance from the source. The Russian school of physicists who have measured the speed of such waves speak of it as " the second velocity of sound in He II.," but it seems to me that no special property of the fluid need be invoked to explain this peculiarity except its superconductivity.

LECTURE II.—*Delivered November 18th*, 1946

The applications of supersonics on a larger scale fall under two heads. There are those which make use of the energy of the high-frequency vibration which can be induced by their aid to agitate various materials, both inorganic and organic. Others use the principle of echo-detection by which a beam of supersonics is made to pulse towards a suspected obstacle, to be reflected there and caught on a suitably-tuned receiver. In this latter use a source of high frequency is essential, as we shall see, but many of the perturbation methods could be equally well carried out with a source of lower frequency. The advantage here of the supersonic source is in its compactness and the fact that the intense vibrational energy can be concentrated into a small region, a thing which would be difficult to do with a source of lower frequency. On the other hand this feature prevents many successful small-scale experiments from being copied on an industrial scale, except with much duplication of the apparatus and at considerable expense.

Of industrial applications in the first class, I shall mention the formation of emulsions, the coagulation of smokes and the degassing of melts. It is readily observed that, when a quartz oscillator is set in intense vibration under oil, the liquid, particularly at the surface, is set into violent agitation; in fact, the liquid may rise above the surface in a fountain which disperses fine oil drops as a foam above it. Place a lighter liquid above the one in which the oscillator is working and you can

disperse one into the other as an emulsion. This process is sometimes used in the manufacture of photographic emulsions, as it is found that a finer grain results. If a supersonic emitter is placed at the base of a glass chimney to which tobacco smoke or a water mist has been disseminated, the particles are harried and brought into collision more frequently than otherwise. This causes coalescence, and the larger particles so formed soon drop to the floor of the chimney. It is necessary that the final resting place of the liquid or solid forming the smoke shall be screened from the radiation, otherwise a certain amount of re-dispersal results.

Gas bubbles suspended in molten metals may similarly be brought to the top and out of suspension. In casting molten metal such bubbles may be occluded and serve to weaken the structure after solidification. The radiation also has a grain-refining

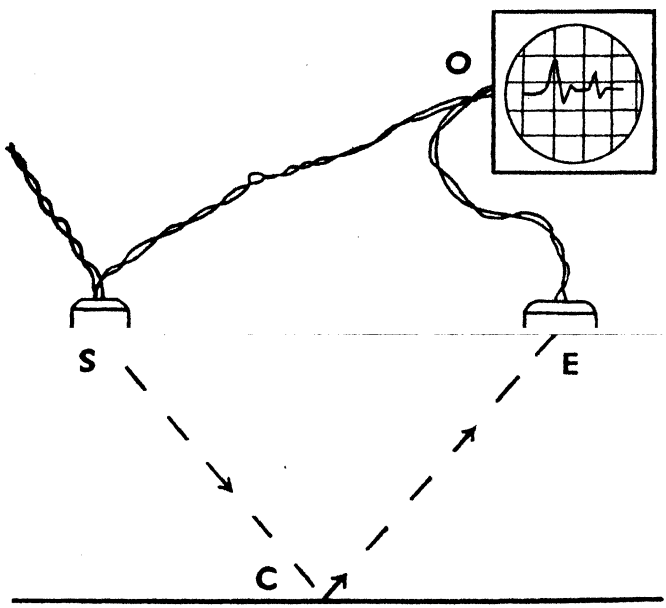


FIG. 7.—*The principle of echo-sounding*

effect. It has been found that when antimony solidifies it does not exhibit its usual tendency to supercool if kept so irradiated. In duralumin similarly treated the grain boundaries which indicate separation of the alloy constituents do not form, while in silumin, needle-like crystals of silicon which tend to separate out are broken up into smaller particles. Such effects are probably due to the setting up of frictional forces between the melt and the crystallites which come out of it during solidification.

It has been suggested that supersonics might be employed for grain-refining purposes during spot welding, the radiation being led into the work through one of the electrode faces or through a third electrode.

Other uses in metallurgy which are either being tried or considered are (1) the prevention, by agitation, of the formation of an oxide coating during the soldering of aluminium; (2) the acceleration of the nitriding process in the hardening of steel;

(3) the hastening of solid diffusion processes—it is already known that supersonic agitation much accelerates diffusion in fluids; (4) the stabilisation of hardness fluctuations in tool steels.

The detection of underwater obstructions by the echoes which they send back to a ship was the first application of supersonics and the *raison d'être* of the Langevin quartz sandwich. Although too late for much use in the first World War, the apparatus, under the name of Asdic, was of great service for detecting submarines in the second. It is well-known that between the two wars a device on the same principle using electromagnetic waves was developed, under the name of radio-location or radar, to detect obstacles in the air. Owing to the great absorption which electro-magnetic waves suffer in water, supersonic waves must be used in the sea.

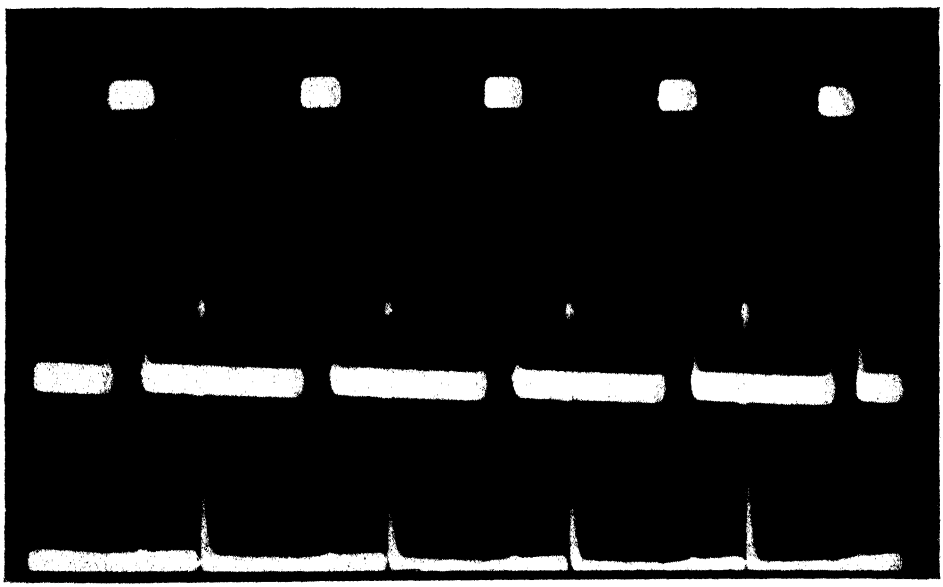


FIG. 8.—*Echo-sounding. The emitted waves (above) and echoes (below) as seen on a cathode-ray oscillograph*

It is interesting to note that high-frequency sound waves were suggested in a patent by Dr. L. F. Richardson for the detection of the submerged portion of icebergs after the *Titanic* disaster, but the means of producing them in sufficient power were wanting until Langevin's invention.

Unfortunately, the similar elastic properties of ice and water prevent a good echo from being obtained off an iceberg, but the supersonic echo-sounder has now become a common piece of equipment for hydrographic surveying, both for delineating the bed of the sea when pointed downwards from the survey ship, or pointing upwards from the harbour bed to measure tidal-height or even wave-height. By the latter means it finds application in assessing the risk of seaplanes landing or of disturbance to small craft at moorings. With the former arrangement even a shoal of fish can be detected.

In the use of echo-detection a transmitting microphone (S, Fig. 7) sends a beam

down until it is reflected from some obstacle (C) whence it returns to fall on the receiver (E). Amplifiers feed some of the transmitting and receiving potential to the plates of a cathode-ray oscillograph, by which the electron spot scanning from left to right is given two vertical impulses. From the distance separating these two jags on the screen the time for the sound to traverse the path SCE may be calculated. Figure 8 shows another way of exhibiting the transmission and echo, using a double-beam cathode-ray oscillograph and sending out a series of pulses (above) and getting their reflections (below) with a lag in time between them.

For all echo-detection, whether sonar or radar, a narrow beam of radiation is essential, unless the reflector is very close to the source, otherwise so much energy

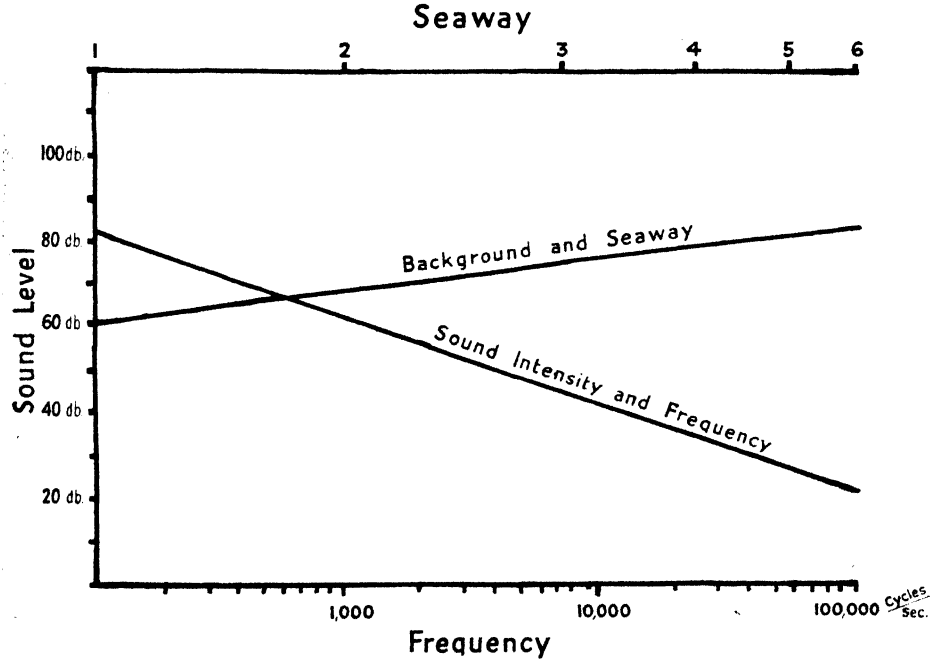


FIG. 9.—*The absorption of sound of various frequencies in sea water in decibels per* 100 *ft.*

is dispersed out of the direct line that the echo caught by a small detector is too weak for use. To get a narrow beam you must use radiation of wave-length small compared with the emitting aperture. Small wave-length means high-frequency, hence the need of supersonics. The radiation is emitted in short pulses, the echoes of which are received by a piezo-electric or magneto-striction receiver, or on the same gear, used alternately as emitter and receiver.

Another factor which must be reckoned with is the increasing absorption which sound waves suffer in a fluid as the frequency is pushed up. This can be noticed by anyone who has used underwater listening equipment. When a hydrophone is laid at some distance from a ship, the low-frequency engine noises and hull vibrations predominate (Fig. 9). This factor, combined with the diffraction we have already noted, sets the optimum frequency for under-water echo-sounding at about 20 kilocycles/sec., just above the audible limit.

In use, the magneto-strictive oscillator in its horn-like housing (Fig. 3) is turned either vertically downwards, if it is the sea-bed which is to be detected—such a record is shown in Fig. 10—or roughly horizontally and scanned round in a circle by rotating the housing, if, for example, submarines are being looked for, just as a radar beam is scanned round the horizon from the transmitter-cum-receiver aerial. In both cases refraction may mar the success of the operation. Just as the meteorological conditions in the atmosphere may bend the radar beam up or down, so the supersonic beam may be turned from the straight path by changes in the properties of the water forming the sea. With the prevailing lapse rate of temperature going down

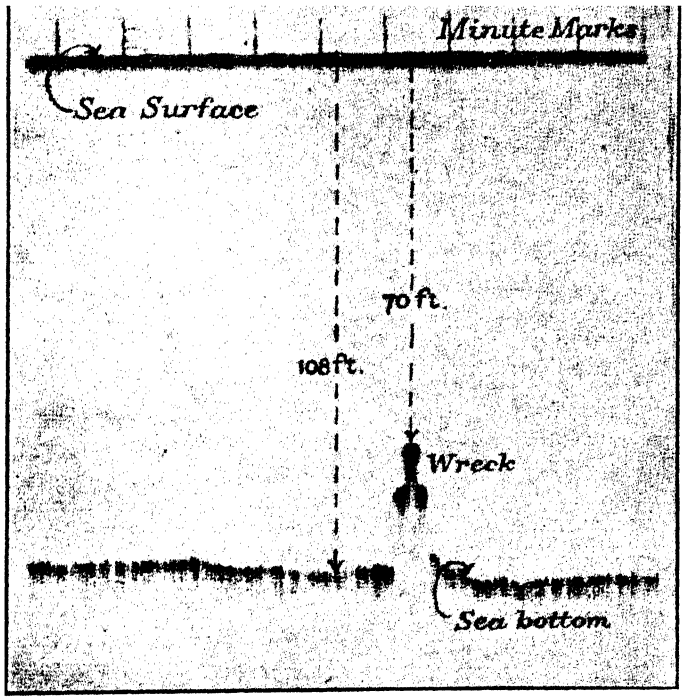
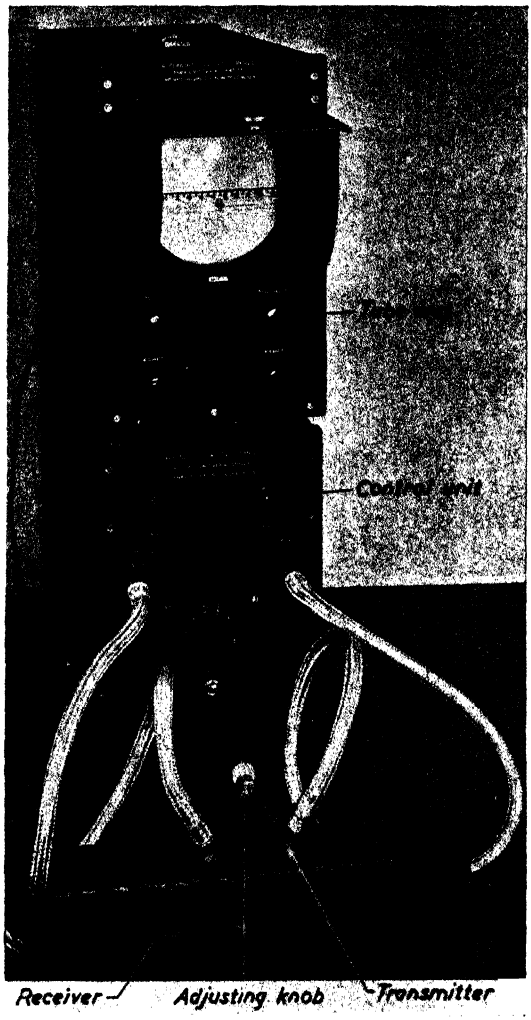


FIG. 10.—*Record of the sea bed on a Hughes echo-sounder*

into the sea the velocity increases slowly and bends an initially horizontal beam slightly down. After a warm sunny day, this bending may become so pronounced as to turn the beam vertically down so that obstacle detection fails. With an inversion of temperature the beam is turned up and does " ducks and drakes " under the surface. Still more peculiar sound tracks may be followed in lakes at the time of the spring " overturns," with a sudden discontinuity in the temperature causing internal reflection. The same thing may happen because of a discontinuity in salinity, where a freshwater stream flows into the sea.

For listening to underwater sounds, as opposed to electrical detection of an echo, a piezo-electric hydrophone is generally used, since its response can be made to vary less with frequency. The oscillations set up in the quartz are still supersonic, but

the " click " marking the onset of its vibrations can be magnified and heard in a loud-speaker. Such a hydrophone scanned horizontally beneath the surface can detect in this way, when it is pointed in the direction of an emitting source of sound, when the ship or submarine concerned is too far off to return a measurable echo to



(Block by courtesy of Iron & Steel Institute)

FIG. 11.—*Flaw detector for use on metal specimens*

the sounding gear. It gives bearing (allowing for refraction) but not, of course, distance.

Before passing on to other peace-time uses of echo sounding, I want to refer briefly to two developments of the Asdic in the latest war.

One of these is the radio-sono buoy, a device for locating submarines and signalling their approximate position to aircraft. The aircraft pilot drops a buoy, weighing about 12 lb., and having an aerial sticking out of the water. The buoy has a high

frequency hydrophone which relays the sounds which it receives, provided they exceed a minimum intensity, by radio waves to the aircraft. By dropping several of these buoys and noting their position, the pilot can assess the position of an enemy submarine from the relative signal strengths.

Another device, the homing torpedo, has two "ears" in the form of high frequency hydrophones, one on each side. From the relative phase or signal strength of the sounds picked up from the propeller of an enemy vessel, relays turn the torpedo towards it just as a person will turn his head towards a source of sound he is locating.

Most of the supersonic noise of a propeller is due to cavitation, so that if a submarine wishes to escape detection by Asdic it must proceed below cavitation speed. There is also a considerable background of noise in the sea on account of surf, etc., which in rough weather may mask the sound of all but the fastest ships. Suggestions have been put forward for a mine exploding under the close action of the sound from a ship, but measurements by the author made during the war show that, unless they are made rather insensitive, such mines may explode under the action of the supersonic background of a rough sea, at any rate near the shore. (Fig. 9.)

A number of Air Force personnel, who had no acquaintance with sea warfare, nevertheless made contact with supersonics in radar training outfits. Since the velocity of sound in water is 1,500 metres per sec. whereas that of electro-magnetic waves is 30 million metres per sec., it is evident that a model radar echo-map using supersonics may be constructed to one twenty-thousandth scale of the actual thing, that is, supposing the time scale is to remain unchanged. Thus to model the device in which an aircraft pilot flying at 5,000 ft., say, obtains by radar echoes the position and nature of the terrain beneath him, a quartz crystal of frequency about 15 megacycles/sec. just under water in a tank 3 in. deep may pulse towards the floor of the tank. A smooth bottom imitates, for radar, the specular reflection which electromagnetic waves suffer at the sea surface; a sandy bottom, the diffuse reflection from a rough ground.

In the actual trainer, a radar emitter and receiver in the same building and controlled by the trainee monitored the supersonic circuits, while the quartz was carried slowly along the tank (at the scale speed) to simulate the steady flight of the aircraft at constant height.

For the detection of flaws in the form of hairline cracks in metals, a system has been developed by the firm of Hughes in this country in which a short train of waves is sent out and its wave-form, as recorded by the receiver, noted on a cathode-ray oscillograph (Fig. 12). They use quartz oscillators sometimes one at each end of an ingot (transmission method); sometimes on two facets of a prismatic specimen (reflection or echo-sounding method). The presence of hairline cracks is shown in the latter method by a number of secondary echoes which reach the second quartz before the main reflection from the base of the prism (Fig. 13). Whereas large fissures may be more readily detected by X-rays, the ultrasonic method is better for spotting these tiny cracks, since it needs but the narrowest break in the continuity of the metal to give rise to a secondary reflection.

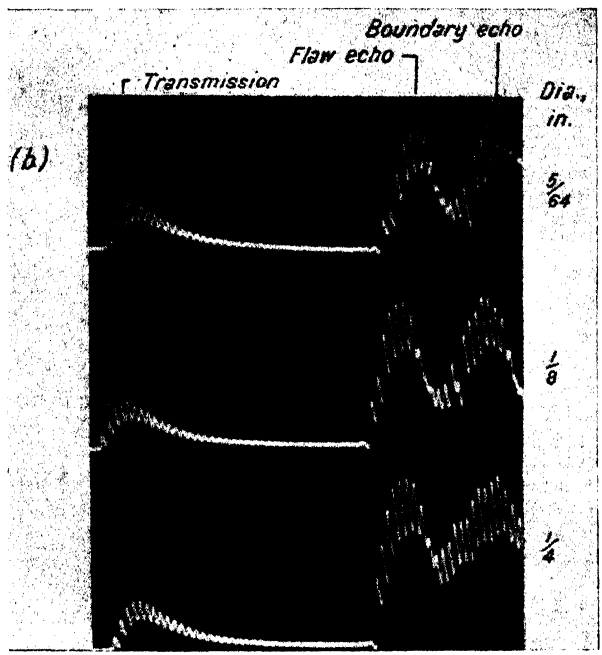
An attempt, in Canada, to "detect" the thickness of the ice cover on lakes has failed, presumably owing to the numerous small air bubbles and fissures in the

structure—an interesting but unforeseen application of a similar system of flaw detection.

These lectures would not be complete without some reference to the biological aspects of these radiations.

The intense vibrational energy associated with the emission can kill small organisms and so leads to processes for the killing of virus, *e.g.*, in tobacco leaf and bacteria, and in the sterilisation of milk; but care has to be taken to sort out effects due to high frequency vibrations from those due to the heat which they produce in the liquid containing the culture.

A French scientist has been using the radiations medicinally in an apparatus which he calls the Ultrasonoscope, which concentrates supersonic vibrations into selected portions of the anatomy in the same way that electro-magnetic radiations



(Block by courtesy of Iron & Steel Institute)

FIG. 12.—*Flaw detector record, showing echoes from holes drilled in the specimen*

are used in short-wave therapy—an instance of a sound application following after the corresponding electrical one.

The most striking aspect of supersonics in the biological sphere is the suggestion, originally due to Professor Hartridge, that bats employ echo-detection to avoid obstacles. Their uncanny facility in doing this is well-known, and, following up Hartridge's idea, some American scientists have been able to analyse the sound output of bats and have shown that they do indeed emit supersonic pulses less than 1 millisecond in duration, and of 100 to 200 kc/sec. Bats which have this faculty atrophied are unable to avoid flying into obstacles in the dark. I believe that experiments are being undertaken under the auspices of the National Institute for

the Blind to find whether human beings can use a similar *ad hoc* apparatus to obtain warning of their approach to unseen obstacles; another instance of the adaptation of a natural faculty in a lower species to an artificial human aid.

(Demonstrations to illustrate the lectures were made by Messrs. H. D. Parbrook, B.Sc., of Newcastle-upon Tyne and W. Halliday, B.Eng., and G. Pearce, B.Sc., of Messrs. Henry Hughes & Son, Ltd., to whom the lecturer proffers his best thanks.)

NOTES ON BOOKS

HUNDRED THOUSAND EXPOSURES. THE SUCCESS OF A PHOTOGRAPHER. By E. O. Hoppé. The Focal Press, London. 1945. 13*s.* 6*d.*

In the voluminous literature of photography, autobiography is by no means common, and autobiography of the calibre of this book by E. O. Hoppé is rare indeed. No man could claim success as a photographer with greater justice, and to have produced a book which provides a unique practical guide to professional photography as well as a most fascinating life story is no small claim to greatness in quite another sphere. It is difficult to write of this book without the appearance of exaggeration, for Hoppé is an exuberant personality, and his book accurately mirrors that personality.

One can extol his photography, and there are surely enough reproductions of superb examples in the book to give a clear idea of what only a few of his hundred thousand exposures produced. One can praise the abounding wealth of practical ideas and hints, or revel in the personal reminiscences of contacts and friendships with the notabilities of the world at large over several decades. Yet that is by no means all, for the author is at once a photographer and an enthusiast, a cultured, experienced and a widely-travelled man. His wisdom is apparent on page after page, and never is there any hesitation in placing it at the disposal of others. Not only is there admirable advice on how to do things, there is usually a detailed account of how a master himself did them. Often the subject is a novel one, and the narration of how the problem was set, its difficulties and the means whereby they were overcome, provides at once an entertaining, and to the budding photographer, a most valuable lesson on how to deal with quite a number of interesting as well as lucrative possibilities covering almost the whole gamut of professional photography.

Throughout the book there runs a thread of most excellent and valuable philosophy. In the beginning it is admitted that chance may play a large part in an individual's life, but it is not lost sight of that a sound business training provides a useful, if not an indispensable foundation to a career. The importance of courage, the value of self-discipline, above all, the essential nature of individuality in building a reputation, also the part played by the social virtues backed by intelligence and an interest in life and in people, all these are indicated as assets to the young professional man or woman and are seen to have had their part in the building of his reputation by E. O. Hoppé. From his first studio in Baker Street to the house of the great Victorian artist, Sir John Millais, in South Kensington, the story is told in much detail, not the least interesting part being that devoted to the planning and decorating of the rooms, including the great studio of the painter which, in turn, became the studio of the photographer. Details of the dark room are not omitted, nor of developers. There is a most illuminating account of how Hoppé makes his enlargements : there is much about general lay-out, furnishing, of colour schemes for the reception room, in fact there is a veritable *vade mecum* for the young photographer, a gift of experience and methods that may well be rejoiced in.

What a world is revealed in his notes on his sitters ! From crowned heads to charladies, from the world of art and music, ballet and the drama to scientists and sinners. These contrasts are no exaggeration for Hoppé himself passes from Mussolini to Maeterlinck, from Clemenceau to Masaryk, and from Kemal Ataturk to Albert Einstein. No matter what his subject there are always

hints of method, scraps of worldly wisdom, valuable bits of "know how" on every page and in almost every paragraph. Even when speaking of some of his many lovely models, and recalling their equally lovely names, Dolores, Sonia, Marita, Eileen, he also recalls the method he used in card-indexing them.

In short it is a lovely book no matter from what aspect you examine it, and one that is instinct with life, optimism and helpfulness. That is no small thing in these days.

H. W. GREENWOOD.

EUROPE AND BURMA. By D. G. E. Hall. Oxford University Press, 1945. 12*s.* 6*d.*

Dr. Hall, formerly Professor of History at Rangoon University, is the acknowledged authority on Dutch and English records relating to pre-British Burma. Here, in a more general work, he gives us, in 182 pages, an account of European contacts with Burma from the earliest times to 1886 when what remained of the kingdom became part of British India.

Although the existence of China was known to Herodotus, South-East Asia—the area variously styled Further India, Malaysia, Indonesia—was unknown to Europeans till the time of Ptolemy. And Burma was among the last parts of the area to become known, lying as she did off the track of our informants, the Indian and Arab merchant seamen. But she was in no way unique, and it is a mistake to speak of her as presenting "the extraordinary fact of a Mongolian people with a civilisation containing more Indian than Chinese elements"; on the contrary, it is a feature of the whole area, save in Annam, that even when the physical stock is mongoloid, the written culture is Indian.

Just as Burma lay too far north of the sea routes, so also did she lie too far south of the land routes. Marco Polo; indeed, when living in China, visited the frontier about 1277, and he may even have crossed it, for he gives picturesque details of Burma. But probably the first European actually to arrive was Nicolo di Conti, a merchant of Venice who travelled overland from Damascus through India about 1430. In the sixteenth century, after the discovery of the route round the Cape of Good Hope, Europeans began to arrive in numbers, but the numbers were small. Burma's products were too bulky and of insufficient value for the limited freight of those days. Her rice and teak did not become a commercial proposition till after 1800. She was known to produce oil, but oil did not become of world value till 1900. Her other minerals were not even known, and mining on any scale developed only with the First World War.

We annexed Burma in three stages. The first annexation, in 1826, when we seized the Arakan and Tenasserim littorals, was an act of pure self-defence, for Burma was an Alice in Wonderland country—having trampled down all her neighbours (including even Siam, for a time), she proceeded to march on Calcutta, and none of our remonstrances was of the slightest avail, her commanders retorting that they would march to England if necessary. The second annexation, in 1852, when we annexed the remaining littoral, Pegu, was doubtless one of Dalhousie's characteristic acts, but it was not entirely unprovoked. The third, in 1886, when we seized the inland heart of the kingdom, was undertaken only after considerable hesitation. We had too many colonial wars for our liking in 1886. But parliamentary opposition was silenced when Thibaw, the last king of Burma, massacred his kinsmen, scores at a time, thus depriving himself of the sympathy he might have got from humanitarians and Little Englanders. And the cabinet's reluctance was removed when France began not only to complete her conquest of Tonking but to show her hand in Burma. Her financiers were obtaining concessions which would have put the Burmese in their power, and her foreign minister, Jules Ferry, not only signed a trade treaty but added a letter promising to supply the Burmese with arms as soon as Tonking was pacified and his officers there were satisfied that there was no danger (the Greek Kalends). When we taxed him with showing an undue interest in Burma, he assured us it was only a trade treaty and that there were no secret clauses. But some months later a copy of his letter was smuggled out of the Burmese palace and given into our hands. Its discovery made a great stir among the rank and file of our officers, and Dr. Hall echoes their opinion when he says "Jules Ferry had deliberately double-crossed us." Our Foreign Office did not think so, remarking that it was only a demi-official letter, that it really

promised nothing, and that Jules Ferry could hardly have avoided giving it, as the Burmese were always dreaming of arms and would not have signed the treaty without a letter of some sort. The letter played little part in our conversations with the French. Jules Ferry's ministry fell, his successor's only desire was never to hear of the colonies, and meanwhile Thibaw had persisted in blackmailing a British timber firm to the tune of a quarter-of-a-million pounds. We would have had to march in any case, quite apart from any rivalry with the French.

G. E. HARVEY.

LANGUAGE AS A SOCIAL AND POLITICAL FACTOR IN EUROPE. By Stanley Rundle. Faber and Faber, Ltd. 1945. 12*s.* 6*d.*

With the Foreign Ministers debating territorial adjustments in Europe, the appearance of this valuable book has been wisely timed, and everyone interested in European affairs (no less than delegates and politicians to whom it should prove indispensable) will welcome Mr. Rundle's lucid introduction to the language problem. Though the author is at pains to point out that this is not a philological treatise and he has no axe to grind, he can hardly avoid being controversial when he comes to examine the claims of rival advocates of artificial languages, and one or two experts to whom words are an obsession may well take less kindly to his sallies than the ordinary reader. In considering Mr. Hogben's claims for his international language *Interglossa*, for example, which presupposes a familiarity with international roots denied to most of us, Mr. Rundle writes: "Hogben further claims that a 'lesson in Zoology is a lesson in Interglossa.' This may be perfectly true for those who study Zoology. Ordinary students of the language would find the converse to be the case." Such felicities are, however, infrequent; and it must be admitted that the author's style, though always clear, is sometimes rather pedestrian.

The book is divided into three sections. In the first, the precise nature of the language problem is carefully examined. "It is perhaps difficult to realise" says the author, "that in the continent of Europe, which represents only one-fourteenth of the total land surface of the globe, there are some forty languages (not dialects) spoken and written: languages in which the respective peoples live their daily lives, conduct their businesses, educate their children, worship, seek their recreation; making in this small continent over thirty cultural groups which are in great measure cut off from direct contact with their fellows."

The history of the spread of these tongues, a story of settlements, conquests and migrations during the last three thousand years or so, is outlined briefly and reliably and the relationship between the languages of the Teutonic, Romance and other groups is indicated by means of simple examples which will be readily understood by the layman. Indeed, despite the wealth of statistics and evidence on every page of wide reading and research, the author never permits his scholarship to become obtrusive —a rare virtue in a book of this kind.

In these days the old guarded language of diplomacy seems to have gone out of favour, and the outspoken speaker at the conference table who "calls a spade a spade" is hailed with satisfaction, at all events by the popular Press. But even a spade may mean something very different from a spade if incautiously interpreted, and Mr. Rundle gives us a fascinating chapter on the disputes and frictions which have arisen (and, alas, always will arise) as a result of mistranslation and linguistic misunderstandings. An apt example, quoted here, of an elementary mistake concerns the French verb *demander* meaning, of course, "to ask," "to request." In its early days the United States Government is said to have received from the French Government at Versailles a polite request for some service to be rendered. The verb used in the note was, quite naturally, *demander*, but the immediate reply of its recipient was, "France demands it, does she? Then she can fetch it!" National feeling is said to have remained high for some time. (One imagines that a problem of present-day interpreters is when to remain discreetly silent, and if Mr. Bevin was correctly reported to have exploded not long ago "The way we are going on seems almost farcical" one assumes the Russian interpreter's attention was conveniently elsewhere at the time).

Consideration of such problems as the differences in cultural and mental outlook

resulting from language differences, the relationship between language and nationality, and the administrative difficulties in States where more than one principal language is spoken (as in Belgium and Switzerland) completes the first part of the survey. The second section—which may be omitted by the ordinary reader, and used by the specialist for reference—comprises a statistical survey, with maps, of the linguistic situation in Europe before the last War, and much other useful information based on the most accurate figures available.

Finally, the possibility of the solution or mitigation of the problem is discussed. Would it be feasible for everyone to learn a number of languages, and if so which should they be? What value is there in the suggestion that the nations should decide on one "international auxiliary language" which all could earn in addition to their own? Is Esperanto or Basic English, or one of the other artificial languages, a solution of the problem? Mr. Rundle does not offer a definite opinion; but he suggests that the three main linguistic groups of Europe being Romance, Teutonic and Slav, it might be possible to devise three simple international languages—Pan-Slav, Pan-Teutonic and Pan-Romance—which the peoples of the groups could learn in addition to their own tongues. The author is wise not to be dogmatic, and the great value of his book is the revelation of how infinitely more complex the subject is than some advocates of this or that international language would have us believe.

The book is produced with Faber's customary distinction, and the Production Department deserves a word of praise for the specimens of various languages given in the Appendix. A few minor typographical errors (*e.g.*, in the quotation on the title page) might be noted when the book is reprinted; and incidentally the word "firstly" is rather to be avoided.

N. A. D. WALLIS.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, JANUARY 6..Farmers' Club, at the Royal Empire Society, W.C.2. 2.30 p.m. W. H. Cashmore, **"Harvesting in Difficult Weather."**

Mechanical Engineers, Institution of, Mining Institute Neville Hall, **Newcastle-upon-Tyne.** 6 p.m., (1) D. M. Smith, **"The Development of an Axial Flow Gas Turbine for Jet Propulsion"**; (2) K. Watson Todd, **"Practical Aspects of Cascade Wind Tunnel Research."**

TUESDAY, JANUARY 7..Chemical Engineers, Institution of, at the Geological Society, W.1. 5.30 p.m. C. C. Hall and A. H. Taylor, **"Chemical Engineering Aspects of the Fischer-Tropsch Process."**

Hull Chemical and Engineering Society, at the Church Institute, Albion Street, **Hull.** 7.30 p.m. E. E. Connolly, **"Instrumentation in the Chemical Industry."**

Kinematograph Society, British, at 16 St. Mary's Parsonage, **Manchester.** 10.30 a.m. D. F. Burnett, **"Projection Optics."**
At the Neville Hall, Grainger Street, **Newcastle-upon-Tyne, 1.** R. Pulman, **"Auditorium Requirements in Sound-Film Presentation—Projection."**

WEDNESDAY, JANUARY 8..Industrial Transport Association, at the Hotel Metropole, King Street, **Leeds 1.** 7.30 p.m. C. H. Henderson, **"Some Traders' View Points."**

Petroleum, Institute of, at Manson House, 26, Portland Place, W.1. 5.30 p.m. L. W. Leyland Cole, **"Petroleum Products in Agriculture."**

THURSDAY, JANUARY 9..Chemical Society, in the Chemistry Department, The University, **Manchester.** 7.30 p.m. Dr. J. H. Schulman, **"On Molecular Interaction at Oil/Water Interfaces."**

Mechanical Engineers, Institution of, in the Engineers Club, Albert Square, **Manchester.** 6.45 p.m., T. R. Oakley, **"Measurements in the Workshops and Tool Room."**

FRIDAY, JANUARY 10..Chemical Engineers, Institution of, at the College of Technology, **Manchester.** 3 p.m. C. E. Rowe, **"Aspects of Pilot Plant Development."**

Mechanical Engineers, Institution of, Storey's Gate S.W.1. 5.30 p.m. (1) D. M. Smith, **"The Development; of an Axial Flow Gas Turbine for Jet Propulsion"** (2) K. Watson Todd, **"Practical Aspects of Cascade Wind Tunnel Research."**

Oil and Colour Chemists' Association, at the Engineers' Club, Albert Square, **Manchester.** 6.30 p.m. A. Hancock and T. F. Brown, **"Paint Settling."**

Physics, Institute of, at the Imperial Hotel, **Birmingham.** Professor J. M. Meek, **"The Nature of the Electric Spark."**
In the New Physics Theatre, The University, **Manchester.** 7 p.m. Professor D. R. Hartree, **"Recent Developments of Calculating Machines in U.S.A."**

WEDNESDAY, JANUARY 15..Electrical Engineers Institution of, Savoy Place, W.C.2. 5.30 p.m. B. Bleaney, J. W. Ryde and T. H. Kinman, **"Crystal Valves."**

THURSDAY, JANUARY 16..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. Dr. H. A. Thomas, **"Industrial Applications of Electronic Techniques."**

Industrial Transport Association, at the County Hotel, Neville Street, **Newcastle-upon-Tyne.** 7 p.m. F. Milton, **"Whither Road Transport."**

Photographic Society, Royal, 16 Princes' Gate, S.W.7. 7 p.m. A. Marriage and D. C. Gresham, **"Masking and its Methods."**

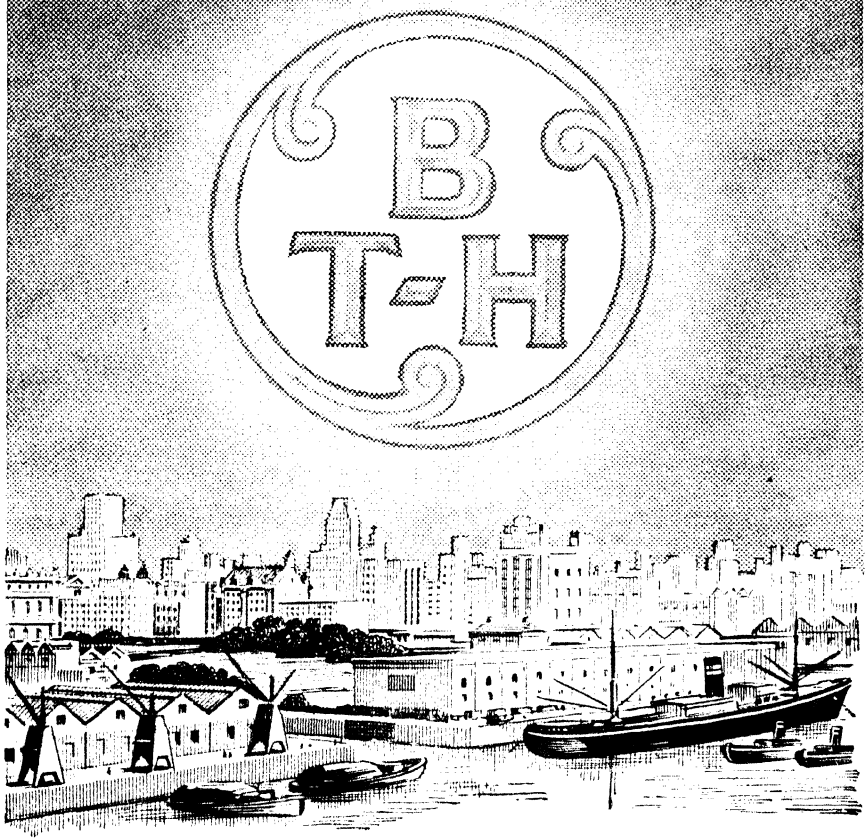
Radio Engineers, British Institution of, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. 6 p.m. M. M. Levy, **"Pulse Technique."**

FRIDAY, JANUARY 17..Chemical Engineering Group, at the Geological Society, W.1. 5.30 p.m. W. D. Jones, **"Flame Spraying of Metals and Plastics."**

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. H. Knowler, **"Recent Developments in Flying Boats."**

SUNDAY, JANUARY 19..Kinematograph Society, British, at the Gaumont-British Theatre, Film House, Wardour Street, W.1, 11 a.m. (1) R. Robertson, **"Technical Design of Projector and reasons therefor"**; (2) Major Bell, **"Projection Room and its Equipment."**

BACKGROUND TO ACHIEVEMENT



Buenos Aires*

— capital and chief port of the republic of Argentina — is one of the most beautiful cities in the world. It has more than a hundred parks, covering an area of over three thousand acres. In recent years industrial and commercial development has been phenomenal; and the scope and efficiency of all public services are of the highest order. Through the port of Buenos Aires and the nearby port of La Plata there pass some three quarters of the country's seaborne commerce.

*Much of the equipment for the electrification of the Central Argentine Railway was provided by the BTH Company. BTH electric plant has been supplied to many important cement works, paper mills, etc. Public, industrial, commercial and domestic lighting uses vast quantities of Mazda Lamps.

BTH RUGBY

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED, RUGBY, ENGLAND

IA 111

How to make the best use of Electricity this Winter

Now that we all realise that there's a very real danger of Electricity cuts throughout this winter, it is essential for everyone to know how to manage with the minimum of inconvenience and discomfort.

This is the problem . . .

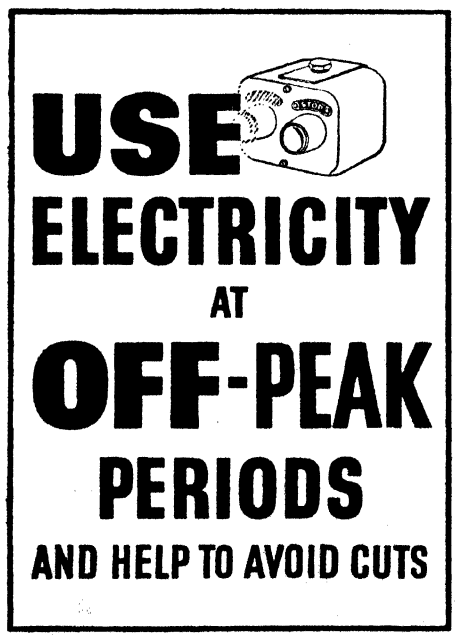
The problem is a very straightforward one. There is not enough Electricity-producing machinery to meet every demand, all the time. Why? Because for six years no extensions or additions to the Power Stations were allowed unless directly needed for helping towards Victory; *none* were allowed for the anticipated higher post-war demands. A vast power plant project, costing over £200,000,000, is now in hand, but this will take *time*. Meantime, the war-tired plant must not be over-strained: if too many people are using Electricity simultaneously, the Electricity engineers *must* switch off for a while.

. . . and THIS is the solution

Don't over-burden the willing horse. Electricity will go on giving you the same faithful service if you'll do *your* part. The heaviest burden comes in the PEAK PERIODS, and if everyone will honestly plan to lighten the load in these periods, *the danger point may not be reached.* At present the PEAK PERIODS are from 8 a.m. until noon, and from 4 until 6 p.m., for five days a week — Monday to Friday. If everyone will transfer some Electrical load to OFF-peak periods, we may avoid some of the cuts. Here's how *you* can help relieve the strain. Just adjust your daily routine so that OFF-peak periods are always the Electricity-using times, and peak periods are the *helping* times. It may perhaps mean inconvenience to you; nobody likes having their carefully-arranged daily programme upset. But it's truly worth it. It is a fact that your Power Station, just now, is relying upon the help that you can give.

No strain means no cuts

If you *do* get cuts you'll know that some people *aren't* helping. But — cuts may well be avoided if everyone helps!



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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4735 *FRIDAY, JANUARY 17th, 1947* Vol. XCV

MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

ORDINARY MEETINGS

WEDNESDAY, JANUARY 22ND, at 5 p.m.—"GAS TURBINES". By Sir Claude Gibb, C.B.E., M.E., F.R.S., Chairman and Managing Director, and A. T. Bowden, PH.D., B.SC., Chief Research Engineer, of Messrs. C. A. Parsons & Co., Ltd. Rear-Admiral (E.) the Hon. D. C. Maxwell, C.B.E., in the Chair. (Illustrated by lantern slides.)

WEDNESDAY, JANUARY 29TH, at 5 p.m.—"ECONOMIC RECONSTRUCTION"—(ii) "A SCIENTIFIC APPROACH TO LABOUR PROBLEMS". By Walter C. Puckey, Director and General Works Manager, Messrs. Hoover, Ltd. The Right Hon. Lord Citrine, P.C., K.B.E., in the Chair.

INDIA AND BURMA SECTION

THURSDAY, JANUARY 16TH, at 2.30 p.m.—(Joint Meeting with the East India Association.) "THE DOON SCHOOL". By A. E. Foot. Sir Harry Haig, K.C.S.I., C.I.E., in the Chair. (Illustrated by lantern slides.)

CANTOR LECTURE

MONDAY, JANUARY 27TH, at 5 p.m.—(First lecture of two.) "THE ADVANCES OF MODERN SURGERY". By A. Dickson Wright, M.S., M.B., F.R.C.S.

OTHER MEETINGS DURING THE SESSION

ORDINARY MEETINGS

Wednesdays, at 5 p.m.

FEBRUARY 5TH.—(*Peter Le Neve Foster Lecture.*) "THE HISTORY AND AIMS OF THE ARMY CADET FORCE". By Major-General R. E. Urquhart, C.B., D.S.O., Director, Territorial Army and Army Cadet Force. Major-General the Right Hon. Viscount Bridgeman, C.B., D.S.O., M.C., Chairman, Army Cadet Force Association, in the Chair.

FEBRUARY 12TH.—"ECONOMIC RECONSTRUCTION"—(iii) "MATERIALS". By F. A. Freeth, O.B.E., D.SC., PH.D., F.R.S., of Imperial Chemical Industries, Ltd. The Right Hon. John Wilmot, M.P., Minister of Supply, in the Chair. (Illustrated by lantern slides.)

FEBRUARY 19TH.—"A CENTURY OF CHEMISTRY". By Sir Harold Hartley, K.C.V.O., C.B.E., F.R.S. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., in the Chair. (Joint Meeting with the Chemical Society to commemorate the Centenary of its foundation.)

FEBRUARY 26TH.—"ECONOMIC RECONSTRUCTION"—(iv) "FINANCE AND THE USE OF MONEY". By A. H. Ensor, Chief General Manager, Lloyds Bank, Ltd. The Right Hon. Lord Kennet, P.C., G.B.E., D.S.O., D.S.C., in the Chair.

MARCH 5TH.—"A LARGE COMPANY CONSIDERED AS A FAMILY". By John J. Calder, Managing Director, Messrs. Ind Coope & Allsopp, Ltd.

MARCH 12TH.—"ECONOMIC RECONSTRUCTION"—(v) "CRAFTSMANSHIP". By Reco Capey, R.D.I.

MARCH 19TH.—(*Cadman Memorial Lecture.*) "BRITISH COAL MINING AND THE INDUSTRIAL REVOLUTION: WITH SPECIAL REFERENCE TO THE LIFE AND WORK OF THE LATE LORD CADMAN". By Professor Douglas Hay, M.C., B.SC., M.I.C.E., Chief Engineer, National Coal Board. The Right Hon. Lord Hyndley, Chairman of the National Coal Board, in the Chair.

MARCH 26TH.—"FLAX UTILISATION". By A. J. Turner, M.A., D.SC., Director of the Linen Industry Research Association.

APRIL 16TH.—"ECONOMIC RECONSTRUCTION"—(vi) "PRODUCTION". By the Right Hon. Oliver Lyttelton, D.S.O., M.C., M.P.

APRIL 23RD.—"ELECTRICITY IN THE HOME". By Miss Caroline Haslett, C.B.E., COMP.I.E.E., Director, Electrical Association for Women.

APRIL 30TH.—"ECONOMIC RECONSTRUCTION—(vii) "DISTRIBUTION". By E. J. B. Lloyd, B.A., LL.B., Director and Secretary, Lewis's Investment Trust, Ltd. The Right Hon. Lord Woolton, P.C., C.H., in the Chair.

MAY 7TH.—"GAS IN THE HOME". By Mrs. G. E. Abbott, Organising Secretary, Women's Gas Council.

MAY 14TH.—"ECONOMIC RECONSTRUCTION"—(viii) "BRITAIN'S ECONOMIC FUTURE". By Alfred C. Bossom, F.R.I.B.A., M.P. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., in the Chair.

MAY 21ST.—(*Selwyn Brinton Lecture.*) "INTERNATIONAL GOTHIC AND THE ITALIAN RENAISSANCE". By Sir Kenneth Clark, K.C.B., Slade Professor of Fine Art, University of Oxford. (Illustrated by lantern slides.)

MAY 28TH.—(*Trueman Wood Lecture.*) "MODERN ASTRONOMICAL INSTRUMENTS". By Sir H. Spencer Jones, M.A., SC.D., F.R.S., Astronomer-Royal. (Illustrated by lantern slides.)

INDIA AND BURMA SECTION

Thursdays, at 2.30 p.m.

FEBRUARY 6TH.—"THE FORESTS AND FOREST RESOURCES OF INDIA". By Sir Herbert Howard, Inspector-General of Forests to the Government of India, and President, Forest Research Institute.

FEBRUARY 20TH.—(*Sir George Birdwood Memorial Lecture.*) "THE VALUE OF GEOLOGICAL SURVEY IN INDIA'S ECONOMIC DEVELOPMENT". By Sir Lewis L. Fermor, O.B.E., F.R.S., formerly Director, Geological Survey of India. Sir Edwin Pascoe, M.A., SC.D., D.SC., in the Chair.

MARCH 6TH.—(Joint meeting with the East India Association.) "ROADS AND ROAD TRANSPORT IN INDIA". By Sir Kenneth G. Mitchell, C.I.E., late Consulting Engineer to Government of India, Roads. Sir Frank Noyce, K.C.S.I., C.B.E., in the Chair.

APRIL 17TH.—"THE INFLUENCE OF INDIA UPON EUROPEAN CULTURE". By Hugh G. Rawlinson, C.I.E., M.A. Sir Richard Winstedt, K.B.E., C.M.G., F.B.A., D.LITT., M.A., in the Chair. (Illustrated by lantern slides.)

DOMINIONS AND COLONIES SECTION

Tuesdays, at 2.30 p.m.

FEBRUARY 18TH.—(*Neil Matheson McWharrie Lecture.*) "RECENT AGRICULTURAL DEVELOPMENT IN CANADA". By Colonel J. G. Robertson, Agricultural Commissioner for Canada. Norman Robertson, High Commissioner for Canada, in the chair.

MARCH 18TH.—(Joint Meeting with the Royal African Society.) "WHITHER SOUTH AFRICA?" By S. Herbert Frankel, M.A., PH.D., D.SC., Professor in Colonial Economic Affairs, University of Oxford.

APRIL 15TH.—"SOCIAL WELFARE IN THE WEST INDIES". By T. S. Simey, Professor

of Social Science in the University of Liverpool. A. J. Wakefield, C.M.G., B.Sc., Inspector-General of Agriculture, and Agricultural Adviser to Comptroller for Development and Welfare in the West Indies, in the Chair.

COURSES OF LECTURES

Mondays, at 5 p.m.

JANUARY 27TH and FEBRUARY 3RD.—(*Cantor Lectures.*) (i) "THE ADVANCES OF MODERN SURGERY". (ii) "APPLICATIONS OF RECENT PHYSICAL DISCOVERIES TO MEDICAL DIAGNOSIS AND TREATMENT". By A. Dickson Wright, M.S., M.B., F.R.C.S.

MARCH 10TH, 17TH and 24TH.—(*Cantor Lectures.*) "ENZYMES". By J. A. V. Butler, D.Sc., of the Courtauld Institute of Biochemistry.

MAY 5TH, 12TH and 19TH.—(*Cantor Lectures.*) "WAR-TIME APPLICATIONS OF PHOTOGRAPHY". By E. R. Davies, O.B.E., F.R.P.S., Director of Research, Kodak, Ltd.

THE PROPOSED INTERNATIONAL EXHIBITION IN 1951

Most Fellows of the Society will already have learnt from the Daily Press that it has been decided to convene on February 6th, at the Society's House, a Conference of organisations likely to be interested in and in a position to speak for various sections of the community upon the subject of the proposed International Exhibition. The appropriate time has therefore come to give some account to members of the Society of the action which the Council have recently been taking in this matter.

At their meeting on November 11th, the Council were concerned at numerous indications that the Government had begun to entertain doubts regarding their announced intention to organise an Exhibition in accordance with the Ramsden report. The Council were unanimous in feeling that such a change of policy was greatly to be deplored and they decided to appoint a small Committee to draft a letter to the Prime Minister conveying their views. This Committee consisted of Viscount Samuel (Chairman), the President, Lord Aberconway, Sir Atul Chatterjee, Sir Thomas Holland and Mr. E. W. Goodale, and the following letter, drafted by them, was addressed to Mr. Attlee:

Royal Society of Arts,
John Adam Street,
Adelphi, London,
W.C.2.
November 25th, 1946.

Sir,

1. The Royal Society of Arts (then the Society of Arts) took the initiative in promoting the International Exhibition in London in 1851, and has joined in advocating the holding of another, and far greater, Exhibition in 1951 to mark the centenary. This proposal, with other matters relating to Exhibitions, was referred for consideration to a representative Committee appointed by the Secretary for Overseas Trade, which recommended as follows:—

"(*a*) Despite the difficulties which must be surmounted, a Universal International Exhibition should be held in London in 1951, or at as early a date thereafter as may be practicable, bearing in mind that, to serve its full purpose, such a demonstration of our recovery from the effects of the war in the moral, cultural, spiritual and material fields cannot be long delayed.

"(*b*) If such an exhibition is organised it must be a dynamic success, and no money or effort should be spared to guarantee that it will surpass any previous international event of the same character.

"(*c*) To achieve the desired ends, it is essential that the exhibition should be sited in central London".

The Secretary for Overseas Trade, in the House of Commons, stated on April 3rd, 1946, that

"The Government are impressed by the views expressed in that report and have decided to accept the recommendation. I am arranging for the necessary preparatory work to be put in hand. This will include the choice of a suitable site in London. As suggestions have been made that Hyde Park should be the site, I may as well make it clear at once that the Government are not prepared to see Hyde Park used for this purpose".

2. The Committee's Report was dated December 17th, 1945, so that nearly a year has since elapsed. But an answer given to a question in the House of Lords on October 30th, 1946, indicated that the whole matter was still in suspense, while estimates were being made as to the availability of the labour and materials that would be needed for an Exhibition in 1951.

3. The Council of the Royal Society of Arts are greatly concerned at this delay. Experience in many countries has shown that Exhibitions are often ill-prepared at the time of opening through preliminary delays. In view of the magnitude of the undertaking, and the many international as well as local arrangements that have to be made, it is unfortunate that a year should already have been lost.

4. With respect to the availability of labour and materials—which must no doubt include incidental demands for hotel and other accommodation in and near London and any improvements in transport that may be necessary—the total can form only a small percentage of the national resources for house-building and other construction. And it may be anticipated that, four or five years after the end of the war, the present acute housing stringency will have been largely overcome.

5. On the other side, account must be taken of the immense economic advantage which the country will derive from such an Exhibition. It can be confidently expected to give a great stimulus to all branches of British trade at home and abroad. In particular it cannot fail greatly to encourage the Tourist Industry, now just beginning to develop: bringing in the future a direct increase in national employment and income, and indirectly an importation of foreign money, which may perhaps go far to recoup the loss of foreign exchange through the war-time sacrifice of British investments abroad.

6. But more important in the long run than any material considerations on the one side or on the other, is the value of such an Exhibition in helping to raise the morale of the nation and its international prestige. As a consequence of the two wars, and of certain intellectual tendencies of our time, a spirit of pessimism is evident, in this as in other countries. Some striking manifestation is greatly needed of the positive achievements of modern civilisation—not

only in the domain of physical science and industrial development, but also in all cultural activities.

The services rendered to the world at large in the recent war by Great Britain and the British Commonwealth, and the hardships suffered and endurance shown by London in particular, make this the right place for such an enterprise; while the centenary of the first International Exhibition ever held undoubtedly offers the right occasion.

It may be well to recall that no International Exhibition has been held in this country for over 70 years.

7. In these circumstances the Royal Society of Arts ventures respectfully to approach His Majesty's Government, and to urge that an immediate announcement be made that the Exhibition will be held in the centenary year and on the scale recommended by the Overseas Trade Committee. Whatever difficulties there may be should be resolutely faced and overcome in the spirit of the pioneers of 1851.

I have the honour to be, Sir,
Yours faithfully,
(Sgd.) BENNETT,
President.

The Right Hon. Clement R. Attlee, C.H., M.P.,
Prime Minister,
10 Downing Street, S.W.1.

To this formal document the President attached the following personal note:

Royal Society of Arts,
John Adam Street,
Adelphi, London,
W.C.2.
November 25th, 1946.

Dear Prime Minister,

It has occurred to me that you would perhaps be interested to know that the Committee appointed by the Council of this Society to consider the communication to be addressed to you regarding an International Exhibition in 1951 comprised the following gentlemen: Viscount Samuel (Chairman), Lord Aberconway, Sir Atul Chatterjee, Sir Thomas Holland, Mr. E. W. Goodale and myself.

Before the Committee was appointed, the Council of the Society gave much attention to the matter and the letter which I have formally addressed to you expresses their unanimous view.

Yours sincerely,
(Sgd.) BENNETT,
President.

The Right Hon. Clement R. Attlee, C.H., M.P.,
Prime Minister,
10 Downing Street, S.W.1.

The Prime Minister acknowledged Lord Bennett's letter on November 28th, and on December 6th replied as follows:

10 Downing Street,
Whitehall.
December 6th, 1946.

My dear Lord Bennett,

I have now been able to look into the questions raised in your letter of November 25th about the proposed 1951 Exhibition. I think perhaps the most satisfactory course would be for you to see the President of the Board of Trade, who could explain to you exactly how matters stand at the present time. If you agree, may I suggest that you should get into touch with Sir Stafford Cripps, to whom I have sent a copy of this correspondence.

Yours sincerely,
(Sgd.) C. R. ATTLEE.

The Right Hon. Viscount Bennett.

This letter was considered by the Council on December 9th, who decided that, with Sir Stafford Cripps' approval, the Committee which had drafted the letter, and Mr. A. C. Bossom, M.P., should join Lord Bennett at the interview, and that, if the outcome of this interview was considered unsatisfactory, the same Committee should take such further action as they might think desirable; as, for example, the holding of a Conference to raise interest and sound public opinion in the question.

Sir Stafford agreed to receive the deputation, and the meeting took place at the Board of Trade on Wednesday, December 18th. The proceedings at this informal Conference may be summarised as follows:—

After Lord Bennett had introduced the deputation, Lord Samuel said that the views of the Society regarding the desirability of an International Exhibition in 1951 had already been expressed in the letter to the Prime Minister of November 25th. He therefore wished, on behalf of the Society, to take a single point, *viz.*, that although the Government had ruled out Hyde Park as a possible site for the Exhibition, the Society still considered it an ideal situation, the adoption of which would automatically eliminate many of the objections now being raised against the holding of the Exhibition. This view was supported by Mr. Bossom, with the additional suggestion that sections of the Exhibition might be located in various sites, with the heart of the Exhibition in Hyde Park.

Sir Stafford Cripps, in reply, said that not only would the use of the Hyde Park site mean the loss of amenities by local residents, particularly the poorer people of Paddington, but the temporary nature of the buildings thereby necessitated would involve the use of materials, such as timber, which were in short supply, instead of concrete, which could be employed on other sites.

Lord Samuel made the further point that the Society viewed the enterprise more from the cultural than the economic angle. With this Sir Stafford agreed, but added that the Exhibition would also be economically beneficial on account of the numbers of visitors which it would bring to the country. As a means merely for

selling manufactured goods, however, the Government felt that the British Industries Fair was more suitable.

In conclusion, Lord Samuel said that the Society had it in mind to sound public opinion on the question of the Hyde Park site by means of a Conference, and hoped that the Government would look favourably upon such an action. Sir Stafford promised to inform the Government of the Society's views and intentions and to send word of their views thereon.

After the interview the Committee decided to proceed with arrangements for a Conference, and on January 7th the President addressed the following letter with an attached Memorandum to over 150 organisations:

Royal Society of Arts,
John Adam Street,
Adelphi, London,
W.C.2.
January 7th, 1947.

Dear Sir,

The Royal Society of Arts (then the Society of Arts) took the initiative in promoting the International Exhibition which was held in Hyde Park in 1851, and has joined in advocating the holding of another, and far greater Exhibition in 1951 to mark the centenary.

The attached Memorandum gives an account of the steps that have been taken to forward the proposal, and of the present situation. It will be seen that a Government Committee, in December, 1945, made a strong recommendation in favour of such an Exhibition; that the Government, in April, 1946, accepted the recommendation; but that the whole matter is now in suspense. The reasons are:—that the Government are averse from the use of Hyde Park as the site for the Exhibition, because they consider that public opinion would not be likely to approve it; that any other site, of sufficient size, would have to be sought outside central London; that this—and indeed any Exhibition on a large scale—would involve a demand for labour and materials that, in view of other claims, could not be met so early as 1951. The memorandum sets out briefly the considerations that may be advanced in reply.

In order that fuller consideration may be given to this question—urgent as it is, and of great national importance—the Royal Society of Arts now invites the attendance of representatives of organisations likely to be interested and in a position to speak for various sections of the community at a Conference to discuss the following questions:—

(1) Whether an International Exhibition on a large scale should be held in London in the near future.

(2) If so, whether Hyde Park should be the site.

(3) Whether every effort should be made to hold it in 1951, the centenary year of the first International Exhibition.

Should the Conference approve the general proposal, a formal approach would then be made to the London Local Authorities and to the Government.

The Conference I have mentioned is to be held at the Royal Society of Arts at 11 a.m. on Thursday, February 6th, when I very much hope that it will be possible for your representative to be present. It would assist in the arrangements for the Conference if you would kindly inform the Secretary of the Society as soon as possible whether you are able to accept this invitation, and, if so, of the name of your representative.

Yours faithfully,
(Sgd.) BENNETT,
President,
Royal Society of Arts.

MEMORANDUM.—(*For the information of organizations invited to the Conference at the* ROYAL SOCIETY OF ARTS *on* 6TH FEBRUARY, 1947.)

PROPOSED INTERNATIONAL EXHIBITION IN 1951

The proposal that an International Exhibition should be held in London in 1951, with other matters relating to Exhibitions, was referred by the Secretary for Overseas Trade to a representative Committee (the Ramsden Committee), which, in December, 1945, recommended as follows:

"(*a*) Despite the difficulties which must be surmounted, a Universal International Exhibition should be held in London in 1951, or at as early a date thereafter as may be practicable, bearing in mind that, to serve its full purpose, such a demonstration of our recovery from the effects of the war in the moral, cultural, spiritual and material fields cannot be long delayed;

"(*b*) If such an exhibition is organised it must be a dynamic success, and no money or effort should be spared to guarantee that it will surpass any previous international event of the same character;

"(*c*) To achieve the desired ends, it is essential that the exhibition should be sited in Central London".

On April 3rd, 1946, the Government stated in the House of Commons that they "were impressed by the views expressed in that report and had decided to accept the recommendation; arrangements were being made for the necessary preparatory work to be put in hand". On October 30th, however, it was announced that the matter was in suspense, while estimates were being made as to the availability of the labour and materials that would be needed for an Exhibition in 1951. Thereupon the Council of the Royal Society of Arts sent a memorial on the subject to the Prime Minister. He suggested that they should get into communication with the President of the Board of Trade, and a deputation from the Society was received by Sir Stafford Cripps on December 18th.

It appears that the present situation is as follows. Suggestions were made that the Exhibition should be held in Hyde Park, but the Government announced on April 3rd, 1946, that they were not prepared to see Hyde Park used for this purpose. No alternative site of sufficient area, however, has been found in Central London; while to go into one of the outlying districts would involve too large an allocation of labour and materials in providing sufficient means of access. In any case, it is thought that there would be difficulty in providing the labour and the materials,

especially timber, for the buildings of the Exhibition itself, wherever located, particularly in view of the requirements of the housing programme. To ensure sufficient hotel and other accommodation for the millions of visitors would also make demands on labour and materials. The Government, therefore, while not having yet reached a definite decision, are doubtful whether it will be possible to hold such an Exhibition in the centre of London at any time, or to hold it so early as 1951 in any place.

The deputation to Sir Stafford Cripps, recognising that to use some new site outside Central London would involve heavy demands of the kind suggested, put forward a plea for reconsideration of the Hyde Park proposal.

The objection is understood to be that the people of London would not agree to give up the use of the park for a period of possibly two years. In reply to this, it may be urged that such inconvenience might well be accepted in good spirit in consideration of the great advantages in view both for London and for the country as a whole, and indeed for the British Commonwealth itself; that Kensington Gardens need not be interfered with, and its use for recreation would remain; that assurances could be given that any damage would be made good (including the replacement of any trees that might have to be transplanted), while no permanent buildings would be left; and that very similar objections were advanced prior to 1851, and were found to be unjustified. Should it in fact be desired to erect any buildings of a permanent character in connection with the Exhibition (conference or concert halls for example), and labour and materials were available, they might be built on some of the many war-damaged sites immediately adjoining the park, to the lasting advantage of the neighbourhood.

Hyde Park would undoubtedly be the most convenient site for visitors; as well as the obvious one for the centenary exhibition. If it were decided upon, the question of elaborate road and railway works and site preparation in some outlying district would not arise. Such labour and materials as were needed would form only a very small fraction of the national resources for house-building and other construction.

As to timber, (*a*) new building materials, including the light alloys, are coming into use and might be largely employed in construction; (*b*) if necessary, some of the principal countries participating might be asked to provide the materials for their own pavilions, and would perhaps be glad to do so, for reasons of economy and to lessen difficulties of exchange.

It may be anticipated that, four or five years after the end of the war, the present acute housing stringency will have been largely overcome.

Furthermore, account must be taken of the immense economic advantage which the country will derive from such an Exhibition. It can be confidently expected to give a great stimulus to all branches of British trade, at home and abroad. In particular, it cannot fail greatly to encourage the tourist industry, now just beginning to develop, bringing in the future a direct increase in national employment and income, and indirectly an importation of foreign money, which may perhaps go far to recoup the loss of foreign exchange through the war-time sacrifice of British investments abroad.

But more important in the long run than any material considerations on the one

side or on the other, is the value of such an Exhibition in helping to raise the morale of the nation and its international prestige. As a consequence of the two wars, and of certain intellectual tendencies of our time, a spirit of pessimism is evident, in this as in other countries. Some striking manifestation is greatly needed of the positive achievements of modern civilisation—not only in the domain of physical science and industrial development, but also in all cultural activities and in its spiritual aspects.

The services rendered to the world at large in the recent war by Great Britain and the British Commonwealth, and the hardships suffered and endurance shown by London in particular, make this the right place for such an enterprise; while the centenary of the first International Exhibition ever held undoubtedly offers the right occasion.

No International Exhibition has been held in this country for over seventy years.

ROYAL SOCIETY OF ARTS,
JOHN ADAM STREET,
January, 1947. ADELPHI, W.C.2.

It will be clear to Fellows of the Society that the President has issued invitations to organisations to the full capacity of the Society's Room and it is therefore much regretted that admission cannot be granted to members of the Society (unless, of course, they attend in the capacity of representatives of one of the organisations invited).

PLANNING RESEARCH FOR INDUSTRIAL DESIGN

By JOHN GLOAG

Sixth Ordinary Meeting, Wednesday, December 11th, 1946

Sir CHARLES TENNYSON, C.M.G., *Chairman of the Central Institute of Art and Design, in the Chair*

THE CHAIRMAN: It is the practice on occasions such as this for the Chairman to introduce the lecturer very briefly, and there is no need for me to be more than brief in introducing Mr. John Gloag. He is one of our greatest authorities on the subject of industrial design, both from the theoretical and practical points of view. He is also a very good speaker and is apt to be exceedingly provocative, which I hope he will be this evening so that there may be a very good discussion. I call on Mr. Gloag to deliver his paper.

Mr. JOHN GLOAG then read the following paper:

Research is an essential preliminary to the conduct of many technical operations; and few manufacturers would use a new material or an untried process, without first attempting to find out as much as possible about their properties and limitations. Such research is obviously necessary, and may be planned and carried through under the direction of technicians whose qualifications are established and whose competence is easily demonstrated and tested. Imagination, giving rise to inventiveness, can and often does operate when such research work is conducted: without it, no new methods would ever come into use, nor would economies and improvements be made in the technique of industrial production.

The manufacturer recognises the validity of research work when it is related to the materials he uses and the methods of production he employs; and acknowledges, at least by implication, that imagination is the generating power of any progress he makes—progress being measurable by the increase of efficiency in production, the lowering of costs, the improvement of the product, and the expansion of the market, which last may be attributable to a reduced selling price, a better product, a better approach to a precise understanding of what consumers want, as a result of market research, or a combination of two or all three factors. But the initial factor has been imagination; though it may not have been called that by the group of people whose work it inspired; nor its operation consciously apprehended. It would be absurd to suggest that our poetical, adventurous and enterprising nation despises or rejects imagination; but the industrial revolution has during the last century blunted our appreciation of the power and place of imagination in industry and commerce. There has always been a tendency to resist innovations that arise from imaginative effort, especially when they are introduced by active minds, whose main pre-occupations are outside the particular productive activity that is affected. This has been apparent throughout our long history as a trading nation. Since the Middle Ages we have been in the habit of forming groups and partnerships of people with complementary skills and marketing abilities; and whenever imagination has been dulled or omitted, and static conditions established, then some change has, sooner or later, occurred, which has led to the reinstatement of imagination, and the consequent collapse of the tidy, protected group or partnership, and its replacement by something virile and enterprising. The ebb and flow of imaginative power are clearly apparent in the period of vigorous production and trading between the end of our medieval civilisation and the tentative beginnings of the first industrial revolution, of which a detailed study is available in Professor George Unwin's comprehensive work, *Industrial Organisation in the Sixteenth and Seventeenth Centuries*. The invigorating possibilities of imagination upon industrial production were suggested at the end of this period by Thomas Sprat, the Bishop of Rochester, in his *History of the Royal Society*. I am quoting from this work, because it illustrates the antecedents of a contemporary problem and indicates an acceptable solution.

The Royal Society was the first learned body that was wholly dedicated to research; and early in its career its members appreciated the significance of research and experiment in relation to the manufacture of commodities, thereby anticipating the habit of mind and type of educated opinion which ultimately found practical and consistent expression through the Society of Arts, which was founded in 1754. I am quoting from the third edition of Bishop Sprat's history (published in 1722), Section XXXI, Part Three, which was headed: "Mechanics are improvable by others besides Tradesmen". After mentioning a few instances of inventions that had been made by men who were not trained for or practising the trades to which they were applicable, the Bishop said: ". . . I dare in general affirm, That those Men who are not peculiarly conversant about any one sort [of] Arts, may often find out their Rarities and Curiosities sooner, than those who have their Minds confin'd wholly to them. If we weigh the Reasons why this is probable, it will not be found so much a Paradox, as perhaps it seem at the first Reading. The Tradesmen themselves, having had their Hands directed from their Youth in the

same Methods of Working, cannot when they please so easily alter their Custom, and turn themselves into new Roads of Practice. Besides this, they chiefly labour for present Livelihood, and therefore cannot defer their Expectations so long, as is commonly requisite for the ripening of any new Contrivance. But especially having long handled their Instruments in the same Fashion, and regarded their Materials with the same Thoughts, they are not apt to be surpriz'd much with them, nor to have any extraordinary Fancies, or Raptures about them.

"These are the usual Defects of the Artificers themselves: Whereas the Men of freer Lives, have all the contrary Advantages. They do not approach those Trades, as their dull and unavoidable and perpetual Employments, but as their Diversions. They come to try those Operations, in which they are not very exact, and so will be more frequently subject to commit Errors in their Proceeding: Which very Faults and Wandrings, will often guide them into new Light, and new Conceptions. And lastly, there is also some Privilege to be allow'd to the Generosity of their Spirits, which have not been subdu'd, and clogg'd by any constant Toil as the others. Invention is an Heroic Thing, and plac'd above the reach of a low and vulgar Genius. It requires an active, a bold, a nimble, and a restless Mind: A thousand Difficulties must be contemn'd, with which a mean Heart would be broken; many Attempts must be made to no Purpose; much Treasure must sometimes be scatter'd without any Return; much Violence and Vigour of Thoughts must attend it: some Irregularities and Excesses must be granted it, that would hardly be pardon'd by the severe Rules of Prudence".

The Section is concluded with an almost pagan urbanity, astonishing in a bishop, who saw fit to use these words: "All of which may persuade us, that a large and an unbounded Mind is likely to be the Author of greater Productions, than the calm, obscure, and fetter'd Endeavours of the Mechanics themselves: And that as in the Generation of Children, those are usually observ'd to be most sprightly, that are the stolen Fruits of an unlawful Bed; so in the Generations of the Brains, those are often the most vigorous and witty, which Men beget on other Arts, and not on their own".

Then, as now, imagination was suspect; though it was and is accepted readily enough under some other name. To-day, imagination operating through approved technical channels is never suspect, because it is employed by technicians to whom the adjectives "wild", "unpractical", "utopian", or, worst and most damning of all, "artistic", are never applied. But directly imagination is related to a technical operation, one that is far from being universally accepted as a practical and necessary operation, the operation of industrial design, it is apt to be suspected by the manufacturer: for he fears its manifestations may be unmanageable and even eccentric, and occasionally a designer in the course of expressing an exuberant personality may abundantly justify such fears. This particular misfortune springs from the reluctance of a designer to regard himself seriously as a technician. But no matter how he thinks about himself; no matter how he chooses to impress an expansive virility upon his clients and the world, he is finally and inescapably a technician. As such he should be recognised and employed—not as a "stunt-monger" or a "bright-ideas" man, but as a technician with a trained imagination. His specialised training and lively, restless type of mind are essential in the planning of research

for industrial design and production. Also he must be introduced at the very beginning of a project; for design, which is imagination in action, is a basic factor. Imagination always returns after a period of exclusion, to active participation in trade and industry, bringing about the formation of new groups of traders and technicians; and that is what is happening to-day: imagination, operating through industrial design, is demanding a place in contemporary industry and everyday life. If we are to use this insurgent force for increasing the prosperity of industry and the amenities of life, the planning of research for industrial design must be recognised as one of the essential preliminaries of industrial production.

In this brief examination of some methods of planning research for industrial design, and corresponding research activities directed to consumer markets, I have referred chiefly to products or objects which may be classified broadly under the heading of "light engineering". The primary problem is the effective reintroduction of the designer to industry, so the best use may be made of his gifts and training. If this technician with the innovating but disciplined imagination is left out of the preliminary research work, mistakes may be made—grave errors of omission, which are revealed only when the ultimate product is fighting for its life in some market, competing with goods that have been designed with complete technical competence: and to-day complete technical competence is unattainable if trained imagination is omitted. Production engineers, metallurgists and other specialists in materials and processes, excellent and able though they may be, either individually or assembled as a team, are seldom capable of co-ordinating and resolving all the problems that arise in planning the production of a commodity. In the initial research, somebody —to repeat Bishop Sprat's vivid specification—with "an active, a bold, a nimble, a restless mind" should be at work, a mind untrammelled by purely technical considerations connected with materials and production, a mind that could come to a conclusion that, shall we say, a metallurgist might not readily entertain, and which would prompt its owner to ask: "What about trying porcelain for the carcase of this job, instead of aluminium or steel?" Or: "Must we have those indicator dials and control knobs scattered about all over the surface? What about tidying them up and assembling them in a row or a group?"

Somebody, several years ago—some unacknowledged and perhaps unconscious practitioner of industrial design—asked questions like that, and somebody listened, so manufacturers began to tidy up the dashboards of motor-cars; for there was a time when they were cluttered with odds and ends, knobs, buttons and dials, dotted about all over the place. This multiplicity of gadgets was once regarded as a selling point; and a humorous drawing in one of the illustrated papers twenty-five years ago depicted how a flashing young car salesman, full of the post-war slang of his day, dealt with a prospective customer who had complained about the meagre proportions of a car in comparison with the size of its price, by saying: "Oh, but, sir, there are oolings of do-dahs on the dash!"

Left to themselves, a team of technicians without an industrial designer may ultimately produce something that works efficiently and is blameless in appearance; but who wants something that is just "blameless" in appearance? To say that a thing is "blameless" is like saying that a man "means well".

Lacking an industrial designer, a team of technicians is often inclined to be

intimidated by prototypes: most people are—it is a human characteristic to seek, consciously or unconsciously, for a precedent. It needs courage to be a revolutionary; to be a constructive revolutionary also needs intelligence, and to be a practical revolutionary demands copious supplies of common sense. The search for a prototype leads to the adoption of disguise. During the last twenty years, the history of the radio set has provided an instructive succession of examples of disguise overpowering design, and design achieving liberation through co-operative research by teams of technicians. At first listeners accepted a naked and untidy assembly of apparatus, with most of the working parts visible. When this was enclosed, after what may be called the "earphone" period, the early radio sets and their loud-speakers were generally imitative; they appeared as cupboards or cabinets, borrowing their external appearance from some inappropriately adapted antique model. One of the first suggestions that the radio cabinet might ultimately disappear as an article of furniture and become incorporated in the house itself as a piece of normal equipment, was made by the late Sir Lawrence Weaver, who used loud-speakers in the form of masks affixed to the walls of his drawing room, which were connected with a concealed radio set. At some future time, when domestic architecture is generally recognised as a branch of industrial design, the controls for the power-operated services and appliances in a house may be assembled in one place, so that light, heat, sound and communications may be as compactly presented to the householder as the controls and dials on the dashboard of a car are presented to the motorist.

Directly independent consultant industrial designers became partners with other technicians, radio sets underwent a complete change of character. When E. K. Cole Limited commissioned such designers as Wells Coates, Misha Black, and Serge Chermayeff, and Murphy Radio Limited brought in R. D. Russell, fresh and vigorous thinking was apparent. Gradually, throughout the industry, disguise was abandoned. Before those enterprising makers made their experiments in design, many manufacturers appeared to have as their chief aim the concealment of the work of their technicians; and the technicians concerned, the electrical engineers and specialists in sound transmission, apparently acquiesced. They produced the parts that worked, and they may or may not have protested against their work being covered up by some ill-conceived extraneous casing, but if they did protest, then they were either unheard or disregarded. The past history of engineering in many of its branches does suggest that the engineer tends to think of his work in an "idea-tight" compartment; he regards it as technically self-sufficient, though he sometimes admits that it requires "trimmings", and occasionally, in a slightly apologetic mood, has added trimmings himself.

In what may be called the pre-industrial designer period of radio set design, the functional significance of the loud-speaker was deliberately minimised. It was often masked by fretwork patterns. Then the industrial designer frankly acknowledged the appliance as an instrument; and thereafter, it became as avowedly functional in appearance as a clock, a speedometer, or a barometer. But even this independent, functionally frank radio cabinet has begun to exercise tyranny as a prototype; and an example of this occurred recently with a team of technicians engaged on experimental research work for the production of television sets. These technicians

produced several models, without an industrial designer, and when these were presented to the manufacturer, he asked this question: "When you are listening to somebody talking, what do you look at?"

It seemed an odd question, and not one of those technicians knew quite what his chief meant. So he went a bit further, and said: "Do you look at a man's mouth or at his eyes when he is talking to you?" Then they grasped what he was getting at: in producing their experimental models for television sets, they had given either equal emphasis to the vision screen and the loud-speaker, or else they had given quite undue prominence to the loud-speaker. That situation would never have occurred had a competent industrial designer been included in the team for that particular piece of design research work.

Even with the industrial designer, the production engineers and the other specialists in processes and materials, the team is incomplete. The sales side must be represented. It is the job of the sales people to be familiar with the market, to know about consumer needs, and to be imaginative about them. And their imagination must also be disciplined and guided by what is known as market research. The late Gilbert Russell defined marketing as "The whole process of perfecting a commodity in the factory, distributing it to the point of sale, and making the consumer want it". He added that if "this process is planned in one operation, it can be carried out with increased effectiveness and economy". He also said "The purpose of market research, which simply means an enquiry into the possibilities and into the conditions existing within a market, is to discover facts at present unknown or not known with sufficient accuracy".

The planning of a market research should, where new products or improvements on old products are concerned, be accompanied by a corresponding research plan for design. To some extent, the framing of the market research may cover questions of design or at least may secure pointers in the course of the investigation, which may be of significance when the results of the research are digested.

Now, before research work of any kind can be done it is extremely important to settle the market objectives. My friend and colleague, Wing-Commander Sinclair Wood, who is an authority on market research, has said: "Markets are people". That is not a smooth generalisation: it condenses into three words the truth, the whole truth and nothing but the truth about markets.

In the nineteenth century people used to be fond of saying "Money talks". Now statisticians and economists have popularised a comparable statement; they say "Figures talk". They do, and a rich confusion of conflicting ideas may arise from their speech, unless they are interpreted by people who are masters of figures and are not mastered by them, who approach them objectively, and who realise that while figures may be manipulated to prove almost anything, they may occasionally prove enlightening, particularly if they are related to specific objectives. "Markets are people". How, then, are markets generally classified? By the purchasing power of people; and when you classify markets by purchasing power, you have simplified the problem of satisfying a market. The cost of goods is, of course, an important consideration; but there are others, difficult and sometimes impossible to measure, and they must be pondered when planning research work for industrial design, for

that work has a corresponding importance with market research, and should indeed either follow or accompany it, step by step.

The team needed for planning research work in industrial design is composed of production engineers, and other technical specialists concerned with materials and processes; an industrial designer, and, from the sales side of a business, marketing and advertising specialists. All these people are technicians, but the one who is qualified by training and character to provide the adventurous creative drive, is the industrial designer.

It is one of the manufacturer's responsibilities to-day to secure for the industrial designer equal status with other technicians, particularly when he is a staff industrial designer. Generally speaking, the independent consultant designer can hold his own and is more readily respected as a technician by production engineers and sales people. Also, the independent designer has a powerful advantage because he is not on the pay roll of the firm; he is brought in at an adequate fee, and that materially changes the attitude of the directors of the business which retains him: they have made an investment, they want to get their money's worth, and they respect a man to whom they are paying a proper fee.

It should be repeated that the designer must be regarded as a technician and not as a source of bright, new, sparkling ideas which will change everything and send the sales curve soaring skywards. If a designer is brought into a firm and the management thinks that, alone and unguided, his inspiration will burn so brightly, will attain such blinding incandescence, that henceforth their business will be suffused with new light, new life and new financial prosperity, it simply means that they are putting the designer on the same level as a fortune-teller or a street-corner quack; they are not regarding him as a professional technician at all, and are expecting miracles and magic instead of technical advice. They wouldn't dream of expecting any other type of professional man, an accountant, say, or an electrical engineer, or a research chemist, to give birth to unsystematic miracles; they would be seriously disturbed if those specialists behaved with such unconventional, not to say occult, originality. The industrial designer then, must be brought into the team as another technician; but one possessing a different quality of mind and a different type of training from other technicians; and the whole team of technicians—designer, production specialists and sales people—must have clear, unmistakable terms of reference before they set about planning any research work at all. Those terms of reference can be determined only by the manufacturer, after he is certain in his own mind what his market objectives are—to what type of consumer his goods are going to appeal. Knowledge of the market, secured by planned market research, is nearly always the preliminary operation which must precede the planning of design research.

"Markets are people". What sort of people now represent markets? Are they interested in good design? There are many manufacturers and retailers who assert, with all the confidence that prejudice instils and indolence maintains, that they *know* what the public wants; you will also find some designers, aflame with reforming zeal, who will tell you what the public *ought* to want. It may be pertinent to suggest that the public is seldom clear about its wants; but, though tempting, it is misleading to make any broad generalisations about public taste. They are apt to

be based upon some extreme case. For example, in the October number of the *Journal of the Royal Institute of British Architects* (Vol. 53, No. 12), there is an illustration of the prototype pair of prefabricated houses designed and erected for the Leeds Council. These houses are clean, straightforward examples of contemporary design; but the tenant of one has expressed his personal taste by covering all the windows with imitation leaded lights. The people who believe in rule of thumb traditional methods of design may contend that such protests against contemporary design typify the taste of the public, and thus excuse themselves for continuing to provide what they have always provided before. But it is a rash assumption that the British public will continue to accept traditional solutions and are always likely to reject contemporary ideas. Nobody knows much about the taste of the public to-day; we know little or nothing about the taste of the young generation that grew up during the Second World War.

Some manufacturers have made tentative experiments in relating market research to the design of their products. A specific example of this was given at a Conference, organised at the Victoria and Albert Museum on October 12th and 13th this year by the Society of Industrial Artists. During an early session of that Conference, an interesting contribution was made by Mr. J. Haydock, of the British Export Trades Research Organisation. In the course of his speech he described an experiment that had been made some months before one of the pre-war radio exhibitions. I am quoting some of his words, because by courtesy of the Society of Industrial Artists, I have been able to make an extract from a verbatim record of the proceedings. Mr. Haydock said: "Radio manufacturers amongst others were faced with the question of design and I do not mean electrical and technical design. I mean the physical appearance of the instruments that they make. Now certain manufacturers, realising that there are different ways of producing a radio set, had made up perhaps half a dozen prototypes of the job and they said to themselves: 'We will have these on exhibition and we will see which sells best'. And on the basis of that experience they would go into production; and I believe it is true to say that there was only one firm which did not employ that method. That particular firm said: 'There must be some guidance we can get from the consuming public about what sort of set is liked'. And it employed a market research company who set about it in the following way.

"They had line drawings made of different types of sets. Some were tall, some short. They asked five hundred members of the public to give them their preference. They had pictures dealing with the position of the various tuning knobs and people were asked whether they wanted one or several". Mr. Haydock mentioned other questions that were asked, about the materials, to discover whether people preferred plastics or wood. This enquiry did not furnish statistics which would have revealed what the perfect set was, but the information secured did enable that firm to say to its design department: "Do what you like to the design, but it must fulfil the following requirements". Mr. Haydock stated that the firm felt "it had got a sufficient lead from the public to give it confidence to go into production" and it was in consequence the only firm at that radio exhibition that was able to quote precise delivery dates to trade buyers.

This was an interesting example of research, though, as Mr. Haydock admitted,

it only settled the question of size. Individual members of the public only saw two drawings, which enabled them to express a simple preference for a tall or short radio set. In 1935, when that research was conducted, there was a ratio of 2 to 1 in favour of the short set. That at least was simple factual information; but the possibility of anybody liking a round radio set was altogether excluded. In tests of a less elementary kind, some attempt must be made to assess the modifying influence of the common reaction of most people when they are questioned about the form or colour of anything—the reaction which makes them quite unnaturally critical, because they feel they ought to say something and they don't quite know what, and it's easier to say something derogatory unless they have the courage to say "Well, I like that, but I don't know why". Unless imaginative interpretation of factual results can over-ride or at least take account of, that fundamentally misleading reaction, then design research directly addressed to consumers may be both unproductive and indeed positively hampering.

There is always a danger that research work may be conducted merely to secure support for some preconceived belief held by a manufacturer and his sales staff. This may be done quite unconsciously, in following our almost inevitable human liking for the lazy way out of any problem. Objective thinking about nearly any subject ranks as the hardest work in the world. We avoid it if possible. That is why it is so important for the terms of reference both for a market research and for the design research that follows or accompanies it, to be lucid, thoroughly understood by all the parties engaged in the work, agreed among them beforehand, and recorded in writing, so there can be no subsequent misunderstanding. It is also important that while nobody associated with a team engaged in design research work should be prohibited from expressing an opinion, the relative value of opinions should be impartially assessed.

Assuming then, that the research team has been formed, and that the industrial designer is in it, and that it has its terms of reference, related to the needs of the consumer market: what must it *do?* The initiation of a great deal of its research work must depend upon the industrial designer. All the other people will know roughly what to do, and what they will want to do is likely to be the habitual rather than the adventurous thing. But no industrial designer can ever be reluctant to study new ideas and techniques. He will want to know all about the materials used: he will ask lots of questions about those materials—some of them, as the other technicians will no doubt point out to him, being rather elementary and even silly questions; but they may start new trains of thought. Those questions may suggest fresh lines of research into the capabilities of the materials employed for a product; they may suggest potential partnerships with other materials, or the use of entirely fresh materials. Experimental work of this kind may suggest research into new methods of fabrication, and the specialised study of optics and colour measurements, and other considerations affecting design.

An illustration may here be given of the way a trained industrial designer clarifies his problem by specific terms of reference; and the subsequent history of the progress of research and the evolution of the design that draws sustenance from that research may be described. I am indebted to Mr. Misha Black for providing the specific example, which is the "Travel Aid" unit he has designed for the London

Passenger Transport Board. I am condensing Mr. Black's own description of the initial work on this unit. This was the problem:

> To design a unit to accommodate traffic maps for Underground railways, buses, trolley buses and Green Line coaches; time-tables, details of first and last trains; a map of the immediate vicinity of the station where the unit is displayed and details of quickest routes.
>
> Intended for all L.P.T.B. stations, the unit must be adaptable for different sites, some with ample space and some congested. The unit must be suitable for economical production in large quantities.
>
> The design must harmonise with the general architectural design of the more contemporary stations and yet be sufficiently distinctive to attract the attention of travellers seeking information.
>
> The materials used for construction must be those which can easily be cleaned and not deteriorate or require frequent reconditioning.

Those were the clear and specific terms of reference to the designer. Here are the designer's solutions:

> The number of posters, maps, etc., to be accommodated made it impossible to display them all on eye level. By tilting the panels it was possible to arrange the smaller units in pairs while, if anything, improving legibility.
>
> The angle of the glass panel, combined with the use of specially designed reflectors, made it possible to illuminate the whole surface evenly, while using only one light source at the top or bottom of each panel.
>
> All units were of the same overall dimensions and capable of various arrangements; in a square; detached from the legs and fixed straight to a suitable wall; in a straight line, with the units back to back—and so on. The panels remain standard in every case and are suitable for mass production; a small variety of different leg units only being needed.
>
> The use of polished wood, inset with brightly coloured plastic panels, toned bronze, enamelled bronze, and glass, ensured the unit remaining in a "new" condition for many years without reconditioning.
>
> Special fixing clips were devised to enable the posters to be easily removable from the sandwich of clear and flashed opal glass, while remaining absolutely flat when in position.

The following steps were taken to reach these solutions:

> Preliminary working drawings were prepared and 1 inch to 1 foot models made showing different methods of assembling the standard unit. Various modifications were agreed after consideration of these models and then drawings were prepared so that a full-size prototype could be built. The working drawings for its construction were related to this specific requirement and were, therefore, substantially different from drawings which would be needed for the mass-produced job. The specification for the prototype had to be suitable for fabrication by hand and with materials easily obtainable under war-time conditions. Instead of extruded bronze sections for frames, for example, a simple steel angle was specified; the short-length fluorescent tubular lighting was replaced by ordinary tungsten lamps; the literature racks were replaced by poster panels (no maps being issued for mass distribution); standard piano

hinges were used instead of the special "secret" hinge intended for the final job. Since maps were not available, they had to be replaced by other printed matter; and the sign was designed for cut-out wood instead of cast and enamelled bronze. The legs, eventually to be of bronze tube, were of painted steel.

This prototype unit has been erected at a selected station. It has been inspected by the various L.P.T.B. officers concerned. The designer visits it from time to time to test whether it is easily visible during rush hours as well as when the station is less crowded; whether travellers looking for information go straight to it or wander aimlessly round the booking hall looking for maps; whether dust collects too easily on the sloping surfaces. Reports are being prepared on ease of servicing, map and poster replacement and fitting new lamps. All this and similar information will later be collated and carefully considered and any necessary adjustments made before production drawings are begun.

This "case history" furnished by Mr. Misha Black, illustrates design and consumer research in complementary operation.

The Design Centres sponsored by the Council of Industrial Design should in time prove invaluable in helping to supply design research teams with information. It is conceivable that in relation to different industries these Centres may sustain a programme of activities comparable with those already in operation in the large and highly specialised business of packaging. The Printing and Allied Trades Research Association is an active and progressive body; and the work it is planning and carrying through exemplifies the thoroughness of technological research which designers in that field can command. According to a recent report published in *Packaging* (Vol. XXVIII, No. 193), this Association is building a Research Centre containing twelve laboratories for different branches of research.

Organisations like the British Colour Council have for some years been of assistance to manufacturers in planning certain types of design research work.

Industrial design is certainly in the news, and British industry can hardly be unimpressed by the mounting interest displayed by the British public in the first large-scale government-sponsored exhibition which is wholly devoted to the operation of design in industry. The attendance figures are of interest alike to all members of the teams I have described, particularly when their work is concerned with the potentialities of the home market. From the opening date until October 31st this year, 729,390 people visited the "Britain Can Make It" Exhibition. The figures have since reached and passed the million mark. On November 2nd, the average weekday attendance was 20,988. The average Sunday attendance was 7,085. Let us suppose that 75 per cent. of the million people who have stood in those long queues at South Kensington, patiently waiting to get into the exhibition, were animated merely by curiosity about what might fairly soon become available in the way of goods; let us assume that they belong to that large class of consumer which has learned to want only what it can get, having been denied the pleasures of exercising choice for so many years. Assuming then that 75 per cent. of the visitors were just uncritically curious, hopeful in a listless sort of way about what they might be able to buy in the future, but nothing more; I would suggest that 25 per cent. were animated by a livelier interest in the form and colour of the things which they

might one day buy and own; and I would also suggest that that 25 per cent. was drawn largely from the "new" public—the new consumers, many of whom have been in the services, and have been denied the privilege of making a home of their own, first by the war and secondly by the housing shortage. Twenty-five per cent. of one million is 250,000. That small nucleus may become influential and increasingly representative of the public taste. I cannot be specific or factual about this, but I can and do suggest that these are the people who are going to be satisfied or dissatisfied with the products of British industry in the future. One day, when this country returns to free enterprise, industry will have to cater for that new public. I think that new public is going to be more critical than the British public has been in the past; critical, because the men and women who compose it have seen how, in time of war, an abundance of mechanical ingenuity and ability is lavished upon making the devices that serve the needs of destruction and defence, devices that are easy to work and easy to keep in order. Manufacturers must inform themselves about the character of these new consumers; so must designers.

Foreign markets need at least as much and often more research than the home market. There are so many local conditions and variations of taste, often associated with native religions and customs. The more obvious needs are connected with climatic conditions, extremes of heat and moisture, the habits and diet of the insect wonders of creation, and the general activities of tropical fauna. Regional superstitions are often responsible for a fixity of taste that is not susceptible to change. There are certain African markets where no representations of human beings or animals may appear on any textile; where certain colours are banned in some areas, but are best-sellers in others. Then there is the egg-cup story—this, I need hardly remind you, concerns an export market—about the manufacturer of egg-cups who was unaware that oriental hens are smaller than ours, and therefore lay smaller eggs, which rattle around inside a British egg-cup. As Holmes said: "Elementary, my dear Watson!" But British industry can't afford to behave like dear old Dr. Watson any longer: progressive manufacturers don't.

Every manufacturer could create an effective instrument for marketing: and Gilbert Russell's definition may again be repeated:

"Marketing is the whole process of perfecting a commodity in the factory, distributing it to the point of sale, and making the consumer want it".

Market research can, within limits, disclose what the consumer wants, and what he is prepared to pay; design research can ensure that the commodity is perfected in the factory; and these research operations should be conducted by specialists who are trained and ready to serve the manufacturer, if the manufacturer makes up his mind about what he wants to do, is sure of his objectives, and supplies all these trained specialists with clear terms of reference. "Markets are people"; and all the partners in modern industry, the manufacturer, the production engineer, the specialist in materials, the industrial designer and the sales manager, can only justify their work and their salaries, if collectively they bring to the service of people integrity, efficiency and imagination.

DISCUSSION

Mr. PERCY DELF SMITH: There are two points in Mr. Gloag's very full paper which

I would venture to underline. First, the absolute necessity of the designer being called in early. This is essential; too often the designer is invited to make an article, already structurally complete, more attractive to the eye. That is quite the wrong way of going to work and I suggest that if there are any young designers here to-day who are asked to do that, it might well re-pay them if they simply said that it was too late and could they please be called in earlier next time. It is not the designer's business merely to add decoration or "streamlining" to an object: as our lecturer has made clear, industrial design is a much more fundamental matter than that and the designer should be called in at the beginning of any plans.

The other point I should like to underline (and I speak as a designer) is one which has been hovering all through Mr. Gloag's paper, although, perhaps, not mentioned specifically, and that is the importance of linking up design with the environment in which it should function. Environment can include many factors: material and the way it is used; the mental as well as the physical atmosphere in which the design is used; and especially does environment include "people", to use Mr. Gloag's word. We have got to link up design with an understanding of people's all-round needs, remembering that they need roses as well as loaves; and that is one reason why designers must not be too specialised in their sympathies and range of thought. Specialisation even in actual work has probably been carried quite far enough, and now we need some at least of our designers to be something more than specialists in specific departments. We want them to take a bigger and broader view and branch out in different directions. If we read the history of design we find often that the best things have been done by outsiders who have "butted into" a particular industry. We all know, for instance, that some of the greatest printers have been amateurs. So I would put in a plea for a widening of such specialisation as is necessary and support our lecturer's desire for more consideration of the whole environment and the many implications of industrial design.

Mr. ASHLEY HAVINDEN: May I say how grateful I am to have this opportunity to hear what I would call a first-class "butter-in" in Mr. John Gloag, who without being a designer has probably done more for industrial designers in this country than anyone, by employing his great skill in creating the conditions in which the manufacturer can use the artist. It is not so much the ability to do good work that is needed, as the ability to create the conditions in which good work can be done by the artist. On the artist's behalf, Mr. Gloag has set himself that aim *par excellence*, and in my view he has succeeded very greatly indeed. I, as a designer, would like to say how grateful I am for the effort he is making on our behalf. There is no shortage of designers but there is really a shortage of Mr. John Gloags in this country. If only there were more of them it would help to bring about the renaissance of English design which we all believe could take place.

Mr. F. A. MERCER: Mr. Gloag has given us a valuable contribution, prepared and delivered with the enthusiasm which we have become accustomed to expect from him. So much so that we are apt to forget the tremendous amount of work he must have done in preparing a paper like this. If there is anyone left here who does not realise that the designer is a technician and part of a team, and that both marketing and technical research is necessary, then he must be one of those people impossible to convert.

I was particularly interested in Mr. Gloag's concluding remarks, which are particularly apposite, in which he said that markets were people. People, he might have added, with all their kinks and peculiarities which make them persons and not robots. In the design and marketing of everything we produce, much depends on the assessment of these peculiarities. He also said that all the partners of modern industry could only justify their work and salaries if collectively they bring to the service of people integrity, efficiency and imagination. That is something which cannot be said too often. We frequently hear to-day, in discussions between capital and labour, the suggestion that the fruits of industry are for capital or labour in proportion to the particular political ideas of the speaker. Both capital and labour are entitled to reward, but it must never

be forgotten that the first purpose of industry is to serve the people. Without service to the people there is no reward, and sooner or later any manufacturer or any labour element forgetting that to serve the people and meet their needs is the first purpose of industry will meet with a very poor reception.

I should have liked to have heard, in connection with marketing research which Mr. Gloag mentioned, something of the importance of travel and of seeing for oneself—both on the part of the executives of industry and of designers. Mr. Gloag and I know something of the importance of the department stores of North America, for example, in giving some indication both of trends and tendencies and of the progress which has been made in competing countries, as well as in the market we are attempting to approach. I am sure that if a great many more people, both designers and executives, would take the trouble to spend even a week in America doing nothing but investigating for themselves the things that are to be seen in the department stores of the cities near the East coast, they would find many reasons for failures in the past and much encouragement and ideas for improvement in the future.

Mr. WARMETT KENNEDY: I should like to ask a question about marketing research. In America some large firms are producing new cars and are spending a lot of money on research to establish design preference. They found, having spent the money, that they had charted the views of the American public at that time but by the time the new model had gone into production those views had changed. A rival firm reconsidered the problem and set themselves the task of predicting the preference of the American public one or two years hence and they worked out a technique. I have always been curious to know what that technique could have been and I am sure that no one but Mr. Gloag is more competent to tell me.

Mr. JOHN GLOAG: I did try to cover that point by saying that when the results of a market research are assessed some allowance must be made for the natural resistance or the unnatural state of mind into which people are thrown when they are asked questions about what they like. When you have the facts of a research in front of you, that is the moment when the trained designer uses his imagination, gets into that incandescent stage, does something courageous, and says "Let us jump ahead of this one". We have done that in this country with much smaller things than cars and with cars too. But I cannot tell you what the process is. It is a case of someone having the courage to go two or three jumps further, and you cannot put down a specification for imagination. Again, I believe the genesis of one of the more spectacular stream-lined cars which jolted the American public in the 1930's was a peculiar, cranky and apparently unworkable attempt to solve the problem of transport—a "tear-drop" shape on three wheels which did 150 miles to the gallon, held the road properly and so on. Every car manufacturer who looked at it nearly fainted. But it started a trend of thought and someone did take three or four jumps ahead, for I believe (though I am not absolutely sure of my facts) that this car, which Buckminster Fuller invented, was the genesis of that stream-lining idea. It is that sort of thinking which some designer does when he is presented with the facts of research and the manufacturer says "That is what they will stand at the moment", and the designer says "Let us go one better". I imagine that is how manufacturers do it; they let someone have their head.

Mr. HARRY JONES: I think there is a misconception over the function of research in trying to find out what the public wants. I do not think you can find out what the public wants. They do not know. I think the most research can do is to reveal what the public needs. I challenge anyone to go to a consumer and ask him what type of car or radio he wants in two years' time. It is the designer who decides that from his deep knowledge of materials, design and trend of design. Raymond Loewy has for years drawn up design trend charts and has rather faithfully predicted the trend in American design, particularly car design. I think that the designer does not get enough credit in that direction, or for the knowledge he has which is carefully built up through years of study of contemporary design in many parts of the world, and his deep knowledge of

materials. The public cannot say what can be done with plastics in three years' time, and it is impossible for them to say what they want; but they can point out what they need. They do not, for instance, want a radio which takes up too much room. In the case of the L.P.T.B. example which we have been given there was a specific need. People want to find their way about quickly and that need was passed on to Mr. Black and he produced a solution to the problem. That is the designer's proper function.

Mr. JOHN GLOAG: I did specifically state that I did not think the public ever really knew what it wanted.

Mr. ASHLEY HAVINDEN: I agree about the artist's sense of trend. In connection with the tear-drop design, I seem to remember that Norman Bel Geddes had something peculiar in the New York Fair as a motor car of some years ahead when these problems are solved. But my impression from conversations with Loewy on this subject has been that it is very difficult for the industrial designer to take a problem as being something for him to solve for all time as it were. As I understand it, problems can be divided into two kinds. One is the finding of an answer to a single uncomplicated problem; for instance, Mr. Black found a direct answer to the need of the passengers for an effective guide and indicator. There was no question there of selling anything. The other kind occurs when a large scale organisation like General Motors Limited go into production. It costs so much money that they have to be very careful before they produce, in hundreds of thousands, a car which may not be immediately liked by the public. The motor car designer's job seems to be to anticipate the next year's trend in public feeling. His problem is not to find an ideal solution to transportation *per se*. If that were actually his job, he could do it easily. His really difficult job is to know just how far to go, and sometimes I think that perhaps he does not go far enough. The manufacturer is probably responsible for this, in his desire to keep improvements up his sleeve as long as possible to help "boost" sales in future years.

THE CHAIRMAN: I think the time has come for me to make a few remarks to sum up what we have heard this evening. Although it may not be Mr. Gloag's function actually to put pencil to paper, he has given a great deal of practical advice on design and has helped to form design in many ways. Certainly he has the main qualifications for designing in that he has "an active, a bold, a nimble and a restless mind". He has displayed them all this evening in one of the best papers I have ever heard. I think a paper which contains a quotation from Bishop Sprat and a description of Mr. Black's design for a transport unit ought to cover the whole of the question from both ends, theoretical and practical. Bishop Sprat's statement on a subject totally foreign to him is perhaps the best on the subject which has ever been made. And what an age when a bishop could make a statement like that! It is very remarkable; I should like to know more about Bishop Sprat.

A great many very interesting things have been said in the discussion. I need not repeat them, but will just add one or two remarks. Undoubtedly there is a tremendously increased interest in design to-day. You see it in all kinds of ways. Mr. Gloag and I saw it to-day when we met at a lunch given by an industrial association where the principal guest was the president of the R.I.B.A. It was an encouraging thing to think that that industrial body was attributing that importance to the architect, who is in a sense a designer. But we have not solved the problem yet, for in spite of all this interest I do not suppose that industry to-day—and perhaps Mr. Gloag can correct me if I am wrong—is making a living for fifty designers of the consultant and general type. Yet we have in this country designers who are every bit as competent as those in America. That number should be increased enormously in the next few years if we are to get the best out of the work of our people.

Similarly, I do not suppose that market research is being carried out as it should be. It is a difficult subject and I am sceptical about a research into radio sets. I doubt whether the best way of ascertaining people's views is to show them drawings of a three-

dimensional object. I have a great interest in this at the moment because quite an elaborate research is being undertaken on the reaction of the public to the "Britain Can Make It" Exhibition. A very detailed inquiry has been made among people coming in, going out and going round. We have found out what they think when they come in and when inside and when they go out. Very important information may come from that. I have seen some preliminary results and they suggest that the bulk of the people who visit the exhibition are under forty. That is rather interesting, I think. It seems to confirm the view which has been expressed that it is the younger people who are more interested in the question of design.

We hope to make a similar research into another subject, namely, the question of utility furniture. Having been connected with it, I do not want to make any defence of it but there have been certain menacing factors about it. Whatever one may say against it, it certainly has provided a clean and efficient design, so far as was possible with the materials and labour available. There have been indications that the public may take to buying utility furniture and buying pieces of fretwork and pasting them on, or to buying those frightful locks and handles made by the lock-making industry in the form of cast-iron fretwork, and substituting them for the plain, well-designed handles made available. These things are disastrous, and we hope that it will only be the over-forties who will buy them, if anybody. That element has got to be allowed for, and is some ground for thinking that if the public is given its head it takes the bit between its teeth and runs away with it. But we must hope for better things than that.*

Mr. Gloag's paper raised a thought in my mind, namely, the necessity for some co-operation between the designer and the scientific research department. That does not seem to have been evolved yet. One attempt has been made in connection with a research which Mr. Gloag mentioned on packaging. The printers did for this purpose associate with their research council a distinguished industrial designer. It was done on the recommendation of British industry. Possibly with a set-up of design centres and research associations, further co-operation between the design and research centres may develop. I think we might get striking results in many industries where the research people will be dealing with the development of materials, because very often a scientist in aiming at certain qualities in materials will produce other qualities, which are meaningless to him, but which may be of immense value to the artist and designer. But the artist and designer may never see them. I feel that a good deal could be done in that way by co-operation, and the designer should be brought in at the very beginning and should go on co-operating right through the particular piece of research.

On behalf of the meeting, I should like to thank Mr. Gloag very heartily for his address, which was certainly most stimulating and comprehensive. It has made us see a great many things about this great problem of industrial design which we had never realised before.

Mr. PERCY DELF SMITH : There is one duty, and I will add pleasure also, which possibly the "under forties" to whom reference has been made, might consider merely traditional, but which we like to maintain in this Society, and that is to thank our Chairman for presiding over the meeting. We all know Sir Charles Tennyson's energetic work and deep feeling on industrial design. He is a very busy man and we wish to thank him formally, both for presiding and also for speaking as he did, at this meeting.

The vote of thanks was carried with acclamation and the meeting then terminated.

**Note.*—A member of the audience was able to supply the following illuminating information in this connection. She writes: "A new furniture shop in a London suburb displayed a notice in its window stating that it would undertake to carve, decorate and repolish utility furniture. A young bride, with a not unnatural desire that her furniture should not look exactly like hundreds of other suites, went in to interview the manager of the shop, and was startled to find that so many orders had been received that it would be at least six months before her furniture could be 'beautified'."

SOME SUPPLY ASPECTS OF REHABILITATION IN POST-WAR BURMA

By A. H. SEYMOUR, C.B.E., M.A., I.C.S.

India and Burma Section, Thursday, December 5th, 1946

(Joint Meeting with the East India Association)

Sir GILBERT LAITHWAITE, K.C.I.E., C.S.I., *Deputy Under-Secretary of State for Burma, in the Chair*

THE CHAIRMAN: I have great pleasure in asking Mr. Seymour to read his paper on "Some Supply Aspects of Rehabilitation in Post-War Burma". There are very few people who are better qualified than he to read a paper on this subject. He has been closely associated with Burma's war effort since the beginning. It was while he was Defence Secretary that negotiations took place which led to the building of the Burma Road, and he has been associated from the very beginning with the development of that highway, which was sometimes termed China's lifeline. He came back at the outbreak of war, and was Controller, and later Secretary, to the Government in Burma for Supplies. After an interval he has for a considerable period been engaged in handling, on behalf of the Burma Government, intricate Burmese problems of supply which have arisen in connection with rehabilitation. He has an unequalled knowledge of the difficulties which have had to be faced in connection with the provision of those supplies, and has had the advantage of personal contact with Burma during the time he has been serving in London. He therefore knows the problem from both ends.

Mr. SEYMOUR then read the following paper:

The title which I have chosen for this paper derives from the fact that throughout the war and since it ended I have been engaged in one form or another in matters connected with supply. The importance of supply as a factor both in the successful conclusion of the war and in the rehabilitation or reconstruction which is war's inevitable aftermath is by now familiar to us all. So familiar is it indeed that it is not easy for the ordinary citizen at home to retain any affectionate enthusiasm for the subject. Docile as we British are by nature, and drilled as we have become by seven years of hard labour and austerity fare, the interest of the man-in-the-street in Supply is now, I fear, unlikely to be aroused to any pitch of fervour until that great day of doubtful distance when he can burst into pæans of praise of Mr. Strachey for permitting him unrestricted liberty to do as he likes with his own digestion, and of Sir Stafford Cripps for allowing him unlimited independence in the choice and extent of his apparel and his domestic goods and chattels.

You will appreciate that against such a background I am somewhat diffident about addressing you on the subject which I have chosen, but I hope that in the course of the paper I shall be able to make the war circumstances of Burma a little better known.

The magnificent resistance to the Japanese by the heavily outnumbered forces with which the name of Field Marshal Lord Alexander is associated, the hazardous exploits of General Wingate and his Chindits in 1943 and 1944, the superb advance of the 14th Army under General Slim through the jungles of Assam and Northern Burma towards the end of 1944 and early in 1945 until the Japanese were swept, as by a flood, in record time from Mandalay to Rangoon and so completely broken as to make their residual occupation of parts of Burma at the time of the unconditional surrender in August, 1945, quite involuntary—all these feats of arms in which so many of the erstwhile ordinary citizens of the United Kingdom have

played a part have, in the minds of all peoples of the world, given to Burma a reality which regrettably enough had not hitherto existed.

Similarly, to those who had never visited the country—and even indeed to those who, as tourists, have " done " Burma in five days—the mental vision of Burma, as a country situated somewhere in the Far East, of impenetrable jungle with elephants nonchalantly tossing teak logs as a Scotsman might toss a caber, of pagodas with bells tinkling in the silent and mysterious night, of fishes flying gaily in the Mandalay air, of girls, almond-eyed and brightly arrayed and laughing as they ate their lotuses and smoked their large cheroots—all this has given way to something more substantial, more accurate, albeit, as I shall have occasion to point out, more sad.

I have thought it best to treat the subject matter of this paper in two parts. I propose, therefore, first to outline the effects of the war on the supply position in Burma from its outbreak in 1939 until the surrender of the Japanese, and thereafter to attempt to say something of the preparations made and the action taken to remedy the sorry supply position as it has existed since Burma was liberated.

Until the fall in quick succession of Norway, Holland, Belgium, and France in the early summer of 1940, war had, if anything, brought a somewhat superficial prosperity to Burma. The country, left as a reasonably prosperous well-running concern at the time of separation from India in 1937, had been developing, with a fair measure of success, her separate individuality. There were some signs of the supply shoe pinching because of the restrictions arising from Exchange and other aspects of Economic Warfare, but these were to a certain extent offset by the stocking-up which, as a measure of foresight had, at any rate in some quarters, been undertaken during the year which followed Munich.

After the fall of France the combination of drastic restriction, throughout the British Commonwealth and Allied countries, of output not directly contributing to the war effort, and of the loss of European markets from which up to that time there had been at any rate some flow of Burma's requirements, began to be seriously felt in Burma. Burma's own surpluses of rice and raw materials, such as timber, metals, and oil, were generally still in demand though shortage of shipping to remove them was beginning to be felt. As to Burma's own requirements, the stock position in India, trade with whom had in normal times represented about 50 per cent. of Burma's both exports and imports, though obviously dwindling, had not as yet caused any great drying up of supplies. It was, however, apparent that the position was bound to deteriorate more and more rapidly. Thus, Burma had by the middle of 1940 commenced very definitely to live on her hump in regard to what she needed, but could not produce herself to maintain her economy. Though she was, owing to her abundance of the rice which is her staple food, never likely to be faced with starvation, her lack of industrial development in terms of factories, the main cause of which was her lack of indigenous iron or coal, inevitably left her very unfavourably placed.

The attack by Japan on Pearl Harbour in December, 1941, and its consequences reacted immediately on Burma. The fall of Singapore in the middle of February, 1942, and the general state of the war at that time when it was necessary at all costs to prevent the development of the threat from Germany to expand Eastwards to the Persian Gulf, made the whole position in Burma most precarious.

In February and March the successful advance on Burma through Moulmein, by the Japanese based on Siam, with its threat to Rangoon from the North, must have made it obvious that at any rate Rangoon and Southern Burma must be abandoned. Up to this time no great material damage had been caused by Japanese air raids except in the direct line of their advancing army. The main damage had been to morale, affecting particularly the labour behind the lines so essential to enable an army to operate. This state of affairs could doubtless have been remedied had it been possible to halt the Japanese. Once, however, it was decided that Rangoon could not be held, the main object in a fighting retreat was to deny to the utmost to the Japanese the supply advantages which they hoped to gain to continue their advance westwards into India. It was then that the real damage and destruction began from which Burma is now attempting to recover. The port of Rangoon, virtually Burma's only up-to-date port, was entirely put out of action by the sinking of vessels in the river and the demolition of wharves and cranes. The one and only power station in Rangoon and oil installations and tankage were wrecked. All craft and railway rolling stock were destroyed or removed and the workshops connected with them put out of action. As the Japanese advanced northwards this same denial took place along the line of retreat. The oilfields themselves were both denied and fought over, and the towns, situated for the most part on the main lines of Burma's communications, by reason of the flimsy and inflammable nature of their structures virtually disappeared in flames following the air raids which preceded their occupation. By the time the evacuation of Burma by the British was complete in July, 1942, there was scarcely one of the fine fleet of 1,000 or more power river craft afloat. The 350 or so locomotives were useless, as was a great part of the 10,000 rolling stock vehicles. Bridges over roads and rivers had been destroyed, and motor transport was as good as non-existent.

The picture that presented itself was one of desolation created as it were over night, a picture which could not but have caused the greatest dismay and bewilderment to a population of 16,000,000 people accustomed in the main to earn a living from the cultivation of crops, the surpluses of which they had always been able to market. These peasants must indeed have wondered why these misfortunes should have come to them in such a remote part of the world, and why soldiers of other nationalities than themselves should be fighting over their country and destroying its economy in their wake. Whatever resentment Burmese national feeling may have felt at the Country's constitutional position, it cannot have welcomed so devastating a change of circumstances unless it were indeed a prelude to self-government and a far greater era of prosperity.

But the problems which confronted the Japanese were practical. The attainment of Far Eastern co-prosperity presupposed the complete victory and domination necessary to make it effective. Unless the Allies were totally defeated there was no hope of a practical demonstration of the prosperity which the Japanese proclaimed, and unless they could effectively advance on India there could be no era of prosperity for Burma, and indeed, the Japanese would not need to be bothered about it. They could, however, make a pretence of giving Burma at once that so-called Independence which was to accompany the promised era of prosperity. This they declared themselves ready to do after the necessary discussions had taken place.

The period between the eviction of the British in July, 1942, and August, 1943, was for the Japanese in Burma one of self-assertion and of consolidation for the next move forward. There was, in fact, no time for serious consideration of the restoration of Burma's economy, and indeed, with the vast resources to which the Japanese now had access through the occupation of Siam, Malaya, and the Dutch East Indies, there was little that Burma could offer which was essential to a further advance on India, with the rich prize which India offered, except to meet the immediate needs for their advance in the way of food and such other ready-to-hand stock supplies as could be obtained by a policy of living on the country. Here the extremely low standard of living of the Japanese Army, judged by Western standards, was of great advantage to them.

So far as the people of Burma were concerned, the main preoccupation of the Japanese was to distract attention from hard and disagreeable facts and propaganda with such outward trappings as could camouflage it, such as a flood of paper money, was the readiest substitute at hand. It was not necessary to give the people bread, and real circuses could be deferred for the time being. By the time, however, that the harvest was gathered in the Spring of 1943, apprehension as to their ability to dispose of surplus crops must have been forcing itself on the minds of the people as a whole, while the delay in the advance of the Japanese on India must have cast serious doubts on the real invincibility of the Japanese.

The Japanese had little concrete to offer as a means of removing these doubts. Their commitments in respect of their vast newly acquired Empire and its long line of sea communications, already proving to be far from invulnerable, were such as to make it impossible for them to utilise shipping except for vital purposes, and, as I have already suggested, it was not vital for Japan either to export Burma's rice or to import the types of consumer goods which the Burman peasant needed to maintain his erstwhile not too high standard of living.

The building up of an Allied Air Force in India was going steadily on and by the end of 1943 there was virtually no life in the ports of Burma, particularly in Rangoon. Circumstances were thus compelling the Japanese more and more to use the land route in any advance on India, and here they hoped to exploit their previous superiority in jungle warfare since they could not accumulate the supplies nor afford the time for the preparation of well-stocked bases or efficient lines of communication.

Inevitably the circumstances of the people of the country were going from bad to worse; and it was then, in August, 1943, that the Japanese decided definitely to proclaim Burma's independence with its gift of separate representation at the Courts of Japan and of such of her Allies or of neutral Countries as were willing to reciprocate. This was a shrewd move and the most attractive form of circus that could be offered. The obligations attaching to the new freedom were, however, stressed and enforced to the full. This new Burma, owing her liberty to the Japanese, was the outpost of the new co-prosperity sphere and must accept privation, assume full responsibility, and marshal all her forces to play her part in the utter defeat of the Allies so essential if the fruits of her liberty were to be reaped. It was on the crest of this wave of so-called independence that the people, purposely kept as uninformed as possible, by lack of communication with the outside world, as to how the war was running, were carried forward to the campaigning season at the end of 1943 and the

beginning of 1944, when Japan was to make her biggest and what she must have known must be her last real effort to enter India. Failure on this occasion must be the end so far as Burma was concerned, and the speed with which the Japanese evacuated or were evicted from Burma would be measured by the extent to which they could afford to stand up to the consequent inevitable loss of face.

And so, with the people of Burma artificially keyed up, yet doubtless with their eyes wider and wider open to the desolation around them, and their ears not unaware of the rumblings caused by the building of a great road by the Americans from India in the extreme North, the Japanese at the end of 1943 and through the Spring of 1944 made their great effort, which came not far short of success, to force the land gates of India. As you all know, the Japanese were held by a resistance which was both desperate and magnificent. Imphal and Kohima, place names known hitherto to perhaps one person among millions, are now imperishable in the annals of the Indian and British Armies. Time does not permit me here to say more than this.

By the summer of 1944 the people of Burma can have had no more illusions as to the worth of Japanese promises. Japan could clearly give them no prosperity. With nothing available from the outside world, for which they could exchange what by hard work in the fields they could produce, with desolation all round them, and with a foreign occupation force whose difficult circumstances revealed more clearly than ever their natural brutality and lack of real concern for the interests of a people with whom they had never had any real ties, the people must have seemed to have plumbed the depths of despondency and disillusionment. There was evidence enough of war and still further devastation in the continued and increasingly powerful air raids to which the country was subjected, and the propaganda, whether internal of the Japanese or dropped from the skies by the Allies, was, to say the least of it, perplexing and brought no comfort in the form of any amelioration of their physical circumstances. It was impossible to form any real estimate of how much longer those conditions were fated to last. One side or the other must presumably win in the end, but when would this be and what would the victors be able to bring of the things that mattered, the things which could bring the country material revival? It was the *things* that the people were interested in, far more than in those who should happen to bring them. The independence which the Japanese had proclaimed they knew well to be a sham. Before the Japanese had come they were, the Japanese had often emphasised, under foreign domination, however much they had or might have benefited from British occupation. The Allies were now fighting the Japanese and Burma was the cockpit. Let it all be over as quickly as possible and then let the contestants all depart with all haste. The purpose of the few observations which I have made on this subject has been merely to emphasise the influence which disruption of economy and shortage of supplies must inevitably have had upon political thought.

From the late summer of 1944 onwards events moved appreciably more quickly than had at one time seemed likely. The 14th Army must have seriously upset the calculations of the Japanese by its ability to outclass the Japanese in jungle warfare, and that too in weather conditions which had hitherto made active operations impossible. The advance of the Allies was steady and unrelenting, and by February and March of 1945, both the Chindwin and the Irrawaddy Rivers had been crossed.

A sweep down through the country from the North, designed to capture Rangoon before the rains broke towards the end of May, became a real possibility, and one that was successfully accomplished, to the complete confusion and splitting of the Japanese forces. So rapid an advance, with lines of communications leading right back through the jungles of Burma and Assam to the Brahmaputra and so through Bengal until her ports were reached, was indeed a major campaign, bringing much destruction in its wake, but leaving little time for much consolidation in the rear. The immediate material advantages accruing to the people were few, and by the time Rangoon was recaptured the overall destruction of the country was greater than ever.

It is, I believe, true to say that the complete reoccupation of Burma by the Allies, by an advance along the route by which they had retreated in 1942, had never really been expected. It had generally been assumed that the recapture of Rangoon from the sea would be an inevitable preliminary, the possession of that port providing a sea base where an irresistible force equipped for all contingencies could be built up. Had events taken the expected turn it would undoubtedly have been essential to repair for further operational purposes with the utmost speed the port of Rangoon and to accumulate all types of material, including ancillary facilities in the shape of workshops, etc., to keep open internal land and river communications. However, the splitting up and the consequent virtual destruction of the Japanese forces in Burma by the successful advance from the North made such preparations of no longer a matter of vital military necessity. Burma's position in the wider strategy designed to accomplish the final defeat of Japan had changed and the building up in Rangoon assumed much more of a maintenance than a capital complexion, with the flow of supplies correspondingly reduced.

In the three months which intervened between the capture of Rangoon and the unconditional surrender of Japan, the broken forces of the Japanese were attempting to escape to Siam by the routes by which they had entered Burma. This was satisactory from a military point of view but disastrous from the point of view of the rice harvest of 1945–1946, since it was from the main granary of Burma, *i.e.*, the southern half of the country, including the Irrawaddy delta, that the Japanese were trying to break out, during the main rice ploughing and planting season, and disorder was rife in every direction when the complete surrender came. Furthermore, a very important consequence of this surrender was that enormous responsibilities were added to the Supreme Commander, South Eastern Asia, in the form of garrisoning almost all the Far Eastern liberated countries, and to that extent the supplies which a continuance of the war would have made available for rehabilitation in Burma were markedly reduced.

In what I have said so far I have tried to give you a bird's eye picture of the circumstances from the supply angle of the people of Burma at the time of the surrender of the Japanese, and I hope I have said enough to bring home to you a realisation of the parlous plight of the Burmese people. Before passing on, however, to the second part of this paper wherein I hope to describe very briefly the measures taken, during the period between our eviction and our reoccupation, to anticipate and supply the needs of Burma as a civil entity, I would like to give in summary form the hard facts which go to prove that Burma, except in the matter of cereal food, suffered far more than any of the other Japanese occupied territories such

as French Indo-China, Siam, Hong Kong, Malaya and the Netherlands East Indies.

(i) The Burma campaign preceding evacuation was of longer duration than that in any other Japanese occupied territory.

(ii) The length of the campaign in Burma made denial action more effective than elsewhere and added to the destruction suffered.

(iii) Burma was the outer limit of Japanese expansion and being an outpost was throughout more vulnerable to counter-attack by the Allies, at first from the air and then by direct re-invasion.

(iv) Burma was less industrially developed than some of the other occupied territories and thus less able by self-help to produce substitutes for what she had been accustomed to import.

(v) The Japanese had access to ample supplies of the raw materials which they needed from the occupied countries geographically closer to Japan herself, and thus there was in those countries some continuing stimulus to maintain production, which was lacking in Burma.

(vi) Burma produced nothing that was vital for Japan to export for war purposes. In such circumstances there was no inducement for the Japanese to risk their shipping in voyages to bring supplies to Burma other than the minimum— and this was very little indeed—for the maintenance of her Forces in Burma.

(vii) Burma was the only country subjected to a second campaign, and that was a major campaign fought right through the country from north to south. The nature of this campaign and the line of advance by the Allies was such as to allow of little reconstruction in the wake of the advance.

(viii) The reoccupation of Burma was in the end effected almost simultaneously with the reoccupation of all other enemy-occupied Far Eastern territories, and the claim of Burma for supplies became one of many simultaneous claims at a time when supplies generally were shorter than ever before.

To turn now to the action taken to anticipate and meet the extremely difficult supply position which it was known must arise when enemy-occupied territories came to be liberated.

It was not until the end of 1942 that the course of the war enabled the Allies seriously to consider this problem. You have possibly not had occasion to give much thought to the preparation needed or the magnitude of a task which involved providing for literally hundreds of millions of people. It was no secret that the war policy of the Allies was to defeat Germany first and then deal with Japan. It followed that the first care was to make provision for enemy-occupied territories in Europe.

The first responsibility for the civilian populations rested naturally with the military to whom it would fall to drive the enemy out and to ensure that they were unhampered by a civilian population likely to cause unrest and subject to disease through lack of the bare necessities of life. The military would, however, equally naturally be eager to pass these responsibilities on to others as soon as conditions were sufficiently settled to make it possible. It was to fulfil this responsibility that Civil Affairs Organisations within and part of the armies themselves were brought into being to function until the Governments of the countries liberated could

assume their own responsibilities. It is important in this connection to bear in mind the distinction between the responsibilities in respect of enemy-occupied territory, *e.g.*, territory overrun by Germany and Italy and their allies, and occupied enemy territory such as Germany and Italy themselves. In the case of the former there was an obligation to re-establish the proper government authority as soon as possible. In the case of the latter, authority must rest with the Military Forces at least until terms of peace were dictated and embodied in a formal peace treaty.

As you well remember, the effect of shortages in all commodities associated with everyday peace-time life was being very severely felt everywhere by the end of 1942. To enable the full resources of the Allies to be utilised to the best advantage and to enable production to be planned on the soundest possible lines, Combined Boards, of United Kingdom and U.S.A. representatives, had been established in Washington to deal with food, raw materials, production and resources, " resources " being generally speaking, everything other than food, raw materials, and shipping. Membership was confined to Great Britain, with whom, of course, were most closely associated the Commonwealth and Empire, and the U.S.A., because they were by far the greatest potential sources of supply. It was natural then that the requirements of all claimants on supply should come before those Boards for planning and production and it was equally necessary that the essentiality of all requirements should be as closely examined as possible before they came before the Boards.

By the end of 1943 the minimum requirements of the territories to be liberated in Europe had been tabulated and examined and the responsibility for procurement allocated as between the military and inheriting civil authorities. Attention was then turned to similar needs in the Far East, and with the establishment of official working parties for the purpose in London in 1944, the probable requirements of Burma came to be considered.

The preceding remarks give in outline an indication of the problem facing those who had the task of making preparations for bringing relief to the masses of the peoples in reoccupied territory in the form both of supplies of the necessities of life and in primary action for reviving internal economy.

At the end of 1943 the Government of Burma in Simla was called upon to prepare detailed estimates of all supplies of every sort which they considered the country, on reoccupation, would need to meet its minimum requirements on the most austere basis and for a period of two years in all. Since London was the centre where all scrutiny of estimates and subsequent preparation of approved programmes, with the procurement implications attaching thereto, were to take place, it was necessary, particularly in the technical fields, for the Government of Burma to be represented in London by Officers of its own who had had long practical experience of conditions in Burma. Accordingly an Organisation, now known as the Burma Office Supply Organisation of which I have been in charge from the beginning, came into being in September, 1944.

I would not wish to weary you with any account of the detailed consultations with a variety of authorities and committees, inevitably accompanied by much form filling and refilling, necessary to establish programmes of requirements for Burma accepted to be the minimum necessary for the prevention of disease and unrest and for primary rehabilitation. Nor do I propose to dilate on the

difficulties caused by shortage of staff which faced anyone engaged on such a task, except to say that they were very real. Time, too, does not permit of my attempting to set out the vast range of supplies needed, except to ask you to conjure up in your minds the supply implications of such broad heads as essential supplies for the civil population, together with the needs of public utilities, key industries and Government services in a country of 16,000,000 people covering an area far bigger than Britain and ravaged in the manner I have already described. I must pass over also the financial negotiations necessary to ensure the provision of funds wherewith to purchase initially what was needed, and must content myself with the somewhat bald statement that by the Spring of 1945 provision of funds as part of an interest-free loan to Burma from His Majesty's Government on some 25,000 items, of variable quantities and of every conceivable description from a household pin to a locomotive, had been agreed to. The actual needs, therefore, of the Civil Government could at last join the torrent of urgent demands flowing into a very restricted procurement channel. The initial processes had been long and irksome, but inevitably so if everyone was to share equitably, and events were moving fast in Burma by the time the way was open to actual procurement. The position would have been desperate indeed had there not existed the prior responsibility of the fighting Forces, whose claims to supplies of every sort took precedence, to make *some* provision for the needs of the civil population and to effect those repairs most essential to their own liberty of movement.

Any student of the actual position of the Far East and British liberated areas must be aware of the acute demands which still persist for consumer goods and other absolute necessities of life. He must also be aware of the current great demand for the main raw materials which those countries can produce and above all for food stuffs in the form of cereals and fats. In reflecting on these matters, however, he must needs appreciate the reaction of these various demands upon one another with consequent complications to the problem of supply in countries which are not entirely self-supporting in pretty well all the necessities of life. And apart from the U.S.A. there are few countries where the raw materials and the manufacturing capacity exist side by side. The producer of raw materials has little inducement to produce surpluses beyond his own immediate needs unless he can exchange the surpluses for something else which he needs. He will not be greatly attracted by an offer of money for his surpluses unless he can buy something else with that money.

In the course of this paper I hope I have succeeded in pointing out both how gravely short Burma was of the necessities of life, other than cereal food, by the time the war ended, how the circumstances and the course of the war inevitably deferred consideration of practical measures for remedying this state of affairs, and how the position was in the end aggravated by the sudden collapse of the Japanese. I would draw attention here to an aspect which, though it should be obvious, is apt to be overlooked. The basic necessities of life in all countries are fundamentally the same, though the quality and the quantity of the commodities concerned vary according to relative standards of living. Consequently the first demands of the peoples of all liberated territories were virtually for the same types of consumer goods, and, quite obviously, with the whole world supply organisation geared to war and not to peace conditions, demands could only be fractionally met at once. The first needs

of man are for food, clothing, and shelter, and the war has created a world shortage of them all because, as regards the first two, surpluses could not be freely moved and it was consequently a waste of war effort to produce them, and, as regards the third, because of the material destruction accompanying war.

The liberated British Far East territories and Burma in particular are undoubtedly deplorably short both of consumer goods and of everything that is needed to rehabilitate their peace-time economy. It serves no purpose to avoid facing this indisputable fact by generalisation on the position of the world as a whole, and every possible remedial measure should be taken. With the knowledge which I have gained by the closest contact with these supply problems, over the past four years spent in London and, for a short period, in India, I can, however, say with confidence that neither Britain nor those who have a particular responsibility to Burma are shirking their responsibilities. Those supplies which the relieving forces could bring with them were, within the time available, regrettably inadequate to afford the immediate relief that was so obviously needed, but what they did bring represented at any rate the commencement of a steady flow of the essential supplies which, during their period of occupation the Japanese made no real effort to provide, even when allowance is made for those practical considerations to which I have earlier referred.

From the moment the Japanese surrendered, and indeed before this in the North of Burma, the Civil Affairs Service, Burma, as part of the fighting Forces and manned largely by personnel either indigenous to the country or who had been many years in Burma before the Japanese occupation, devoted themselves wholeheartedly to the task of repair and improving the lot of the people in every possible way. Everything that could be utilised and spared from military supplies was brought in and used to good purpose. The task was immense and, where the derelict city of Rangoon was concerned, Augean. Much was effected during the period between May and October, 1945, when the Civil Government was officially restored by the return of the Governor. Since that date the fighting Forces have continued to render all assistance within their power in the way of supplies and co-operation in the restoration of law and order which has been one of Burma's most difficult problems. The flow of those supplies, which had scarcely gone into production by the time Rangoon was recaptured, has been steadily increasing from the United Kingdom, from India, and from such other sources of supply as those authorities which have by now taken the place of the Combined Boards have been able to recommend, though the supply has not as yet by any means caught up with demand. All types of supplies had to be planned and procured by official action as long as controls and lack of facilities for normal trade to re-establish itself made this necessary. Every possible removal of control likely to hinder freedom of movement of goods into Burma has been advocated and welcomed by the Government of Burma and it has already been possible to transfer in several fields responsibility for procurement from the somewhat ill-accustomed shoulders of Government to those of the trade. Meanwhile, with the arrival in Rangoon of more and more supplies under official procurement, the more immediate problems are at present those of storage and of distribution. Plans for restoration of agriculture and timber, Burma's two primary industries, first set in motion by the Civil Affairs Service, have been developed along the most productive lines, while every-

thing possible is being done to restore the transport facilities so essential for this development. The end of the war has brought no relaxation for those who have the real interests of Burma at heart.

I fear I have already exceeded my allotted time. It has not been easy to prepare this paper both for lack of leisure and because the subject, at any rate in my particular world, looms so large and covers so vast a sphere that it is very difficult to compress it in a readily intelligible form. While I am very conscious of its deficiencies I can, I hope, at least claim not to have gone outside the somewhat broad title which I have chosen. I could, of course, have read out to you long lists of figures of imports and exports, of supplies procured, to be procured, and not procurable, of world availabilities as compared with normal, etc., etc., but since the value of figures so far as Burma is concerned could only be truly assessed by comparison with similar figures in respect of other countries, the result of such an approach could only have been a series of dull tables requiring much concentrated study. I hope, therefore, that so far as a meeting of this sort is concerned, I have been right in following the line of Parliamentarians who, when asked to supply information of too exacting a nature, are wont to reply that the labour involved would not be commensurate with the results likely to be achieved.

I shall, however, be very glad to attempt to answer briefly any questions that arise in the discussion.

DISCUSSION

Mr. J. K. MICHIE: I have no question to ask, but I should like to say a few words as one who has some knowledge of the background against which Mr. Seymour has read his interesting and comprehensive paper; and because, as he and I know, business people were associated with the attempt first made in India by C.A.S. (Burma) to estimate what was needed for Burma when the time came to send goods out. I have also seen Burma as it was a year ago; and I can, unfortunately, endorse all that Mr. Seymour has said about conditions there; the lack of goods, the destruction of property, and so forth. I also know that much has been done, both before I was there and since, in getting things going particularly on the supplies side. Then there was a mere trickle of goods, for as you probably know, it was not what had been ordered for Burma by the Army that got there but what the South-East Asia Command decided Burma should get of what was coming east for all the liberated countries. In those days goods were arriving in Burma without invoices—just being dumped in Rangoon with inadequate protection—and the position was most confused. Much of that has been altered. The port is handling very much more, and much more is going out both from official and unofficial sources; and although in regard to supplies and rehabilitation generally the situation is not all we should like, still much is being done and much more, we hope, will be done, subject to shipping being available.

I do not think there is anything more I can usefully add except to say as a business man that whatever British business can do to assist the movement of goods to and the resuscitation of industry in Burma is being done and will be done; and we shall continue to ask for, and obtain I am sure, the help of Mr. Seymour's Department or whatever authority succeeds it.

U SAW OHN TIN: First of all I should like to say that the presentation of this vast and complicated subject by Mr. Seymour has been very masterly; I only wish that the people of Burma could be told the story in the same way. We all know that when supplies were being sent to Burma at the beginning, the people were apt to be impatient of the slow moving machinery of the supply organisation. But to my way of thinking the people are not to be blamed for that, because if they were taken into our confidence and

told of the vastness and complexity of the problem and of the undertaking, I think they would be willing to share the joys and sorrows, or shortcomings and triumphs, of this great undertaking; and this would benefit the whole future of Burma, both commercial and political.

Another point which I should like to mention has reference to export. It is all very well for goods to be going to Burma of which Burma is greatly in need—and we are grateful for those things—but we have to look ahead. Burma could not continue to import every year, even with the help of an interest-free loan. We must work for ourselves and must pay for those imports, and how are we going to pay for them? I do not think that it is premature to think of exports at any time, because the exports of a country cannot be built up in a month or a year. I trust that this generous loan given to Burma will be utilised in such a way as to rehabilitate the great industries—agriculture and so on. Here again, I should like to say that the Burmese people should be taken into confidence and told where and how this loan is being spent, so that they know where and how to pull their weight. I think I am right in saying that without the co-operation of a vast number of the Burmese people the building up of our export trade to pay for the imports of Burma cannot be accelerated.

Group-Captain H. St. Clair Smallwood: I shouid like to ask our lecturer if he can give us an idea of whether the oilfields of Burma are likely to produce and thereby enable supplies to be bought by Burma in exchange for oil. That has been a big export in the past and I should like to know whether the industry is likely to come to life again.

There is another point about which I should like to ask. I had anticipated news about the giving up of the roads from India into Burma. They were built with blood and sweat and, having lived in Burma in the days of shortage of communications, I know how terribly urgently roads are needed. Could Mr. Seymour re-assure us that those roads will not be allowed to revert to jungle? I feel that some organisation might be initiated, as was done with the China end of the road, to keep the road in repair.

Sir Htoon Aung Gyaw: I must congratulate Mr. Seymour for his able paper. He has presented the problem of supply in its true perspective and has shown clearly the tremendous destruction in Burma, of which very few people in this country know. The whole length and breadth of Burma, from north to south, was fought over, and all the towns have been wiped out. It is a terrible thing to see a town of 50,000 people with housing accommodation for only 10,000 left. The rest just live high and dry without shelter and without any clothes, without any means of maintenance. Most of the towns have been destroyed in varying degree—anything between 35 per cent. and 85 per cent. Sometimes whole towns were wiped out.

It is against that background that we must look at the supply problem, or the demand position, which necessarily involves very large quantities. The whole economic life of the country is dead, and transport has broken down. I very much appreciated the way Mr. Seymour brought this state of affairs into proper perspective. I know that we Burmese have been rather impatient. We have had to be, because the country even now is in a very sorry state. There is no effective administration, and this is surely due to the economic breakdown. There is political discontent, but it is really discontent of the present conditions. That is the position in Burma, and the sooner we can get the economic life of the country going the better.

I was a member of the Government and we did what we could for agriculture; but that again is conditioned by the state of affairs. Only 60 per cent. of the cattle population survived, and that is a limiting factor. Great efforts have been made to resuscitate the timber industry, and all the people producing timber are making great efforts to provide the timber to rebuild houses to shelter the people. Oil has been mentioned and there perhaps I might be allowed to answer the question. The whole problem concerns machinery, and the machinery required is of a very specialised kind, available mostly from America. Some machinery has been ordered, and a few orders are arriving. A few firms are producing a little, but there is nothing like the pre-war production. The

production of oil, however, is not the whole question. There is also the important matter of refining. We have no machinery for that now, although we were equipped before, but I believe some is on order. Again it is simply a question of getting hold of the machinery.

With regard to the question about the roads in Burma, it is true that we should very much like to have the roads. The Burmese people realise their importance, especially during the last war when the fighting forces had few roads to move on, but this question of the two new roads is a difficult matter which really concerns the north-west portion of Burma and the north-east portion of India. There is nothing in that portion of Burma which the people of Assam want and *vice versa*. It is very difficult country and the maintenance of a road like that probably would not be at all economical. The army required a labour force of 20,000 people to maintain it. There is no question of the villages along the way being able to provide the labour to maintain their own bit of the road. It is even doubtful if it is necessary to maintain it on strategic grounds. The war was won really by transporting soldiers and supplies by air, and that is the new technique.

Sir GEOFFREY MANDER: There is another type of oil, which was produced in the Shan estates—tung oil. I should like to know what has been done to enable that industry to carry on.

THE CHAIRMAN: I do not propose to endeavour to enter into the technical aspects of this question, because Mr. Seymour can deal with them better than I can. One thing which was made clear from the picture Mr. Seymour drew for us of the circumstances in which Burma came into the war and of her sufferings during the war, is the excessive devastation to which Burma has been subjected. It is very difficult to get across to people in this country how great that devastation is. People know that there have been campaigns fought there, and that damage has been done, but they have no picture in their minds of the widespread and intense destruction, the extent to which her communications were interrupted and destroyed and the extent of her losses of equipment in terms of locomotives, rolling stock and road transport as a result of those campaigns, either from air bombing, or in battle, or from the ordinary pillage which accompanies the defeat of an army. It is, as Mr. Seymour said, against that very difficult background that this problem of reconstruction has had to be considered, and the immensity of the destruction has made the problem more serious than would otherwise have been the case.

Secondly, Mr. Seymour has brought out very well the importance of the fact that the collapse of the Japanese was so unexpected. If the Japanese collapse had taken place later, as most of us thought that it would, it would have been easier to plan and to make certain arrangements. Of course, we were only too happy that the collapse came when it did; and it saved parts of Burma and the country at large much suffering and misery. But so far as local supply is concerned it had an unfortunate effect. When Burma came into the market she found herself competing in a market of world shortages, in which everyone wanted consumer goods; and strong and real as Burma's claims were, she was not so well placed as she would have been had she been the only country demanding these things.

Then followed a long and up-hill battle to get to Burma what has been got there. Mr. Seymour has played a wonderful part in the work that has been done, and we have had the fullest possible assistance. It would not be fair to pass over the active and friendly help given in Burma itself first by the Armies as they reoccupied the country and in the period after Burma had been liberated. With the work of the Civil Affairs Supply Branch one should associate the present Governor, who for many months was at the head of that organisation, and who did service of very great and real value.

I think we can take consolation and some little pride perhaps from the assurance which Mr. Seymour has given us that whatever possible has been done and is being done even in the face of these competitive demands to put Burma on her feet again.

It is a slow process, but those of us who have been close to the work have been able to observe with some little happiness and satisfaction the upward trend. None of us but could wish it were faster, but the progress made is real. All we can do is to continue the efforts made and to rely for the arrival of the balance of the goods on the help of the great commercial industries and firms, and on private procurement, whether Burmese or European, which play so large a part in business of this type.

I should like to say how grateful I have been to Mr. Seymour for the interesting exposition of the very complicated problem of supply which he has given us.

Mr. A. H. SEYMOUR: I feel that the audience has let me off very lightly! Only three specific questions have been put to me and it really does not fall within my province to answer any of them. My very good friend, Sir Htoon Aung Gyaw, has replied to the points raised by Group-Captain Smallwood regarding oil and roads. My organisation has not been interested in any particular industry as such. We have been attempting to procure what the Government of Burma, in Burma, has decided is needed for the primary—and I stress that word—rehabilitation of Burma. As far as oil is concerned, apart from such assistance as we have been able to give to the oil companies in a general way, we have not had any specific responsibility for procuring supplies necessary for the rehabilitation of the oil industry as such. I am grateful for the great help I have received from the oil companies, primarily from the Burma Oil Company. We had the responsibility for seeing, so far as possible, that steps were taken to help the oil companies to arrange for oil and lubricants generally to be made available in Burma until such time as the indigenous sources of supply started again. But since the Government of Burma was not in a position in these early stages to assist in the actual financial rehabilitation of the oil companies, because its resources are very limited, it was left to the oil companies to make arrangements for their rehabilitation in accordance with their own programme.

I am afraid that I cannot really answer Captain Smallwood's questions any more extensively than Sir Htoon Aung Gyaw, who made a very apt reply to the question raised about the Burma roads, which were built purely for operational purposes. He said that if the roads are to be maintained by Burma they must show some return. If the roads are required for international communications then Burma will look to the other countries interested for help, but if they are to be looked at from a local point of view then the Government of Burma must consider whether they are worth maintaining.

With regard to tung oil I can only say the same thing. It is a new and modern industry in Burma and what its future will be no one can say. It has always been a very minor industry and as far as the Government of Burma is concerned, with the great need for re-establishing the main economic industries of Burma, rice and timber, it has not been possible to afford any material assistance to the tung oil industry. My department has not taken any steps to produce the supplies which are necessary to the tung oil estates. Because that is so I have not indeed any real knowledge of what would be required to get the tung oil industry going in terms of machinery. I imagine, however, that the capital cost is not very large and tung oil is not a big revenue producing industry in Burma.

Mr. Ohn Tin emphasised the importance of Burmese exports. There is no cause for worry about there being the fullest demand for whatever Burma can produce. I think it can definitely be said that all the authorities in Burma and outside do appreciate how vitally important Burmese rice is, particularly at the moment. There is no doubt that every grain of rice which Burma can produce surplus to her own requirements will find the readiest of ready markets. It is up to everyone to do everything they can to expedite the production of the greatest possible surplus of rice. The disposal of exports from Burma is a very minor problem in present circumstances. Mr. Ohn Tin also said that a paper such as I have read was useful and informative, and he wished that the Burmese were given a little more information on the same lines. As far as that is

concerned we have not been acting in any way in secret. Everything we have been doing is known to the Government of Burma, but we have not had a publicity department. I do feel that, if Mr. Ohn Tin's view is accepted, as I think it should be, any representations on that subject could and should be made to the Government of Burma in Rangoon, because those there are in a position to give all the information which we could.

My old friend Sir Htoon Aung Gyaw has spoken kindly about what I have said. He was Finance Minister before the Japanese came to Burma, and then was in Simla advising the Government. He then went back and was finance member of the Executive Council, so he has considerable knowledge of finance and, of course, the whole circumstances of Burma. I am grateful to him for adding, as a Burman with the knowledge he has, to some of the points which I had made in a rather general way in a paper which had to be compressed and which was not very easy to prepare.

Sir JOHN WOODHEAD, G.C.I.E., K.C.S.I.: It is my pleasure to propose a hearty vote of thanks to our lecturer and to our Chairman. We have listened to a most interesting description of the economic position of Burma. The damage that country suffered through the war has been tremendous and I am sure that this lecture has brought home to us very clearly indeed, more clearly perhaps that we had realized, the tremendous destruction Burma has suffered through being the cockpit of the fighting in the Far East. Her railways have been destroyed, her refineries wrecked, her ports greatly damaged, her inland steamers and barges destroyed, and her towns largely burned. She is now where she was about 70 years ago, and I think that expresses very clearly indeed the dreadful economic position she is in to-day.

One can not help feeling that perhaps we in this country and the peoples of other countries are not doing all we can to assist Burma in her recovery. It is impossible, until one has seen the destruction, to realize the damage which war causes in a country which has been the scene of severe fighting, not only in one series of battles but in two. Burma has been particularly unfortunate because not part but the whole of her territory suffered from the war, and I wonder whether we in this country—and it is perhaps useful to remember that India has not suffered as Burma has suffered—could not do something more to assist Burma in her tremendous task of reconstruction. I am not asking for any reply to this question; if I were not a "free-lance" at the present moment I would not dare put it forward.

I ask you to accord a hearty vote of thanks both to our lecturer and to our Chairman.

The vote of thanks was carried with acclamation, and the meeting then terminated.

GENERAL NOTES

THE "BRITAIN CAN MAKE IT" EXHIBITION.—Addressing a large gathering of Press representatives at the Victoria and Albert Museum last week, Mr. S. C. Leslie, C.B.E., Director of the Council of Industrial Design, said that, in the fourteen weeks of its life, 1,432,369 persons had visited the Exhibition. Three-fifths of these appeared to be under 40 years of age, whilst the children numbered 161,000.

The Exhibition had been publicly launched only ten weeks after V-J day, and most of the commodities had been submitted within fifteen months of the end of the war in Europe. Of the 15,836 items submitted to them for exhibition, the Selection Committee had chosen 5,259 articles from 1,297 firms.

The setting of the Exhibition had fully realised the Council's wish to demonstrate the capacity of Britain's young experts in this field. The designers and artists who created the setting could be credited with making good at one stride what had hitherto been one of the weakest aspects of British salesmanship.

From the point of view of export trade, the Exhibition was launched in order to demonstrate that the quality of British goods was equalled, in the case of the best, by the excellence of their design. The Exhibition had not been conceived as a Trade Fair intended to capture immediate overseas orders, but as a demonstration of quality—a long-term national prestige advertisement. Nevertheless, it had produced a substantial volume of trade enquiries from both home and overseas buyers. In addition to trade buyers from this country, more than 7,000 buyers came from overseas; over a thousand from the Commonwealth. Unofficial estimates of the volume of orders have been published, varying from £25,000,000 to £50,000,000.

The effect of the Exhibition on the design policies of manufacturers, exhibitors and non-exhibitors alike, had been striking. From reports received it was evident that, so far as British manufacturers and traders were concerned, Industrial Design is "on the map" to a greater extent than ever before.

The Council of Industrial Design are planning to hold other national exhibitions of Industrial Design at intervals in future. Meanwhile, "off-shoots" of the "Britain Can Make It" Exhibition, in the form of a small travelling exhibition, containing a few of the furnished rooms, the section on Industrial Design and a limited selection of domestic commodities, will be seen in the Provinces. It is hoped that in association with the Federation of British Industries and with the co-operation of the local Chambers of Commerce, a series of "Design Weeks" will be held in different provincial centres. In addition to the travelling exhibition, these "Design Weeks" will include meetings and conferences, and possibly window display competitions.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, JANUARY 20..Anthropological Society, Royal at the Royal Geographical Society, Kensington Gore, S.W.7. 5.30 p.m. M. Fortes, R. W. Steel and Miss P. Ady, **"The Ashanti Social Survey, 1945-46."**

University of London, King's College. 6 p.m. Professor S. J. Davies, **"Gas Turbines and their Prospects."**

TUESDAY, JANUARY 21..Dyers and Colourists, Society of, at Field's Cafe, **Huddersfield.** 7.30 p.m. Dr. T. Richardson and E. K. Wiltshire, **"The Package Dyeing of Cotton by the Pigment Method."**

Eugenics Society, at the Royal Society, Burlington House, W.1. 5.30 p.m. Sir Alexander Carr Saunders, Sir Cyril Burt and Dr. J. H. Fraser Roberts, **"Relation of Intelligence to Fertility."**

Hull Chemical and Engineering Society, at the Church Institute, Albion Street, **Hull.** 7.30 p.m. W. F. Archibald, **"Calcium Carbide Manufacture."**

Industrial Transport Association, at the Royal Society of Arts, John Adam Street, W.C.2. 6.30 p.m. S. W. Black, **"Shipping."**

Kinematograph Society, British, at 16 Prince's Gate, S.W.7. 7 p.m. H. E. Dance, **"Films and Film Strips in Schools."**

Physics, Institute of, at the University, **Edinburgh** Professor P. I. Dee, **"Photography of Atomic Tracks."**

WEDNESDAY, JANUARY 22..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. T. S. Andrew and T. R. Reyner, **"Switchgear Alarms and Indications."**

THURSDAY, JANUARY 23..Chemical Society, in the Chemistry Lecture Theatre, The University, **Liverpool.** 5 p.m. Professor H. A. Krebs, **"Metabolic Cycles."**
At the University College, **Swansea.** 6 p.m. E. J. Bowen, **"The Absorption of Light."**
University of London, King's College. 5 p.m. Sir Alan Herbert, **"The Talking Shop."**

FRIDAY, JANUARY 24..Chemical Society, in the Chemistry Department, Marischal College, **Aberdeen.** 7.30 p.m. Dr. D. P. Cuthbertson, **"Recent Advances in our knowledge of the Metabolism of Proteins and Amino Acids."**

Electrical Engineers, Institution of, Savoy Place, W.C.2 5.30 p.m. H. Cobden Turner and G. M. Tomlin, **"The Application of Electrical Technique to the Service of some other Industries."**

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. F. T. Barwell and J. C. W. Humphrey, **"Materials New to Engineering."**

SATURDAY, JANUARY 25..Foundrymen, Institute of British, at the Waldorf Hotel, W.C. 2.30 p.m. B. Levy **"Broad Aspects of Patternmaking with special reference to a new Machine Development."**

MONDAY, JANUARY 27..Shaw Society, Mary Ward Settlement, Tavistock Place, W.C.1. 7 p.m. Mr. Geoffrey Thomas **"The Works of Ibsen."**

TUESDAY, JANUARY 28..Architects, Royal Institute of British, 66 Portland Place, W.1. 6 p.m. Professor W. G. Holford, **"New Towns."**
Physics, Institute of, at the Royal Society, W.1. 5.30 p.m. Professor H. S. W. Massey, **"Semi-Conductors."**

WEDNESDAY, JANUARY 29..Kinematograph Society, British, at the Wellcome Foundation, 183 Euston Road, N.W.1. 7.15 p.m. D. F. Cantlay, **"16 mm. Processing Laboratory Projection."**

THURSDAY, JANUARY 30..Chemical Society, at the University, **Sheffield.** 5.30 p.m. Professor J. B. Speakman, **"Some Relationships between the Structure and Properties of Natural and Synthetic Fibres."**
Photographic Society, Royal, 16 Princes Gate, S.W.7. N. McQueen, **"Animation in Scientific Films."**
University of London, King's College. 5.30 p.m. Professor R. J. H. Jenkins, **"Palamas."**

FRIDAY, JANUARY 31..Chemical Society, at University College, **Dundee.** 5 p.m. Dr. W. G. Campbell, **"Modern Trends in the Chemical Utilisation of Wood."**
Mechanical Engineers, Institution of, Storey's Gate S.W.1. 5.30 p.m. F. F. P. Bisacre, **"The Life of Carbide-tipped Turning Tools."**
University of London, King's College. 5 p.m. The Hon. Mr. Justice Denning, K.C., **"The Divorce Laws."**

SATURDAY, FEBRUARY 1. Interplanetary Society, British, at St. Martin's Technical School, Charing Cross Road, W.C.2. 6 p.m. A. V. Cleaver, **"Interplanetary Flight: Is the Rocket the only answer?"**
Physics, Institute of, at the University College, **Cardiff** 3 p.m. Dr. L. J. Comrie, **"Some Applications of Calculating Machines."**

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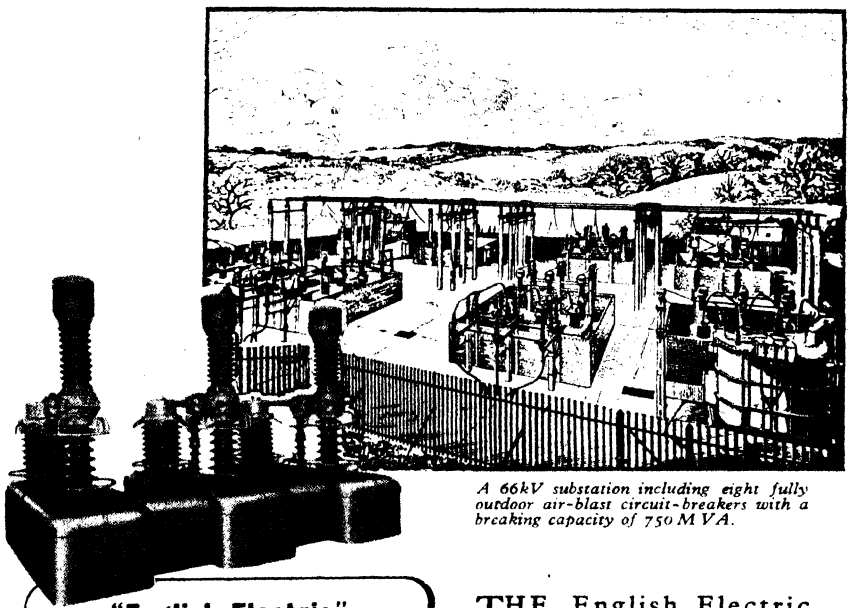
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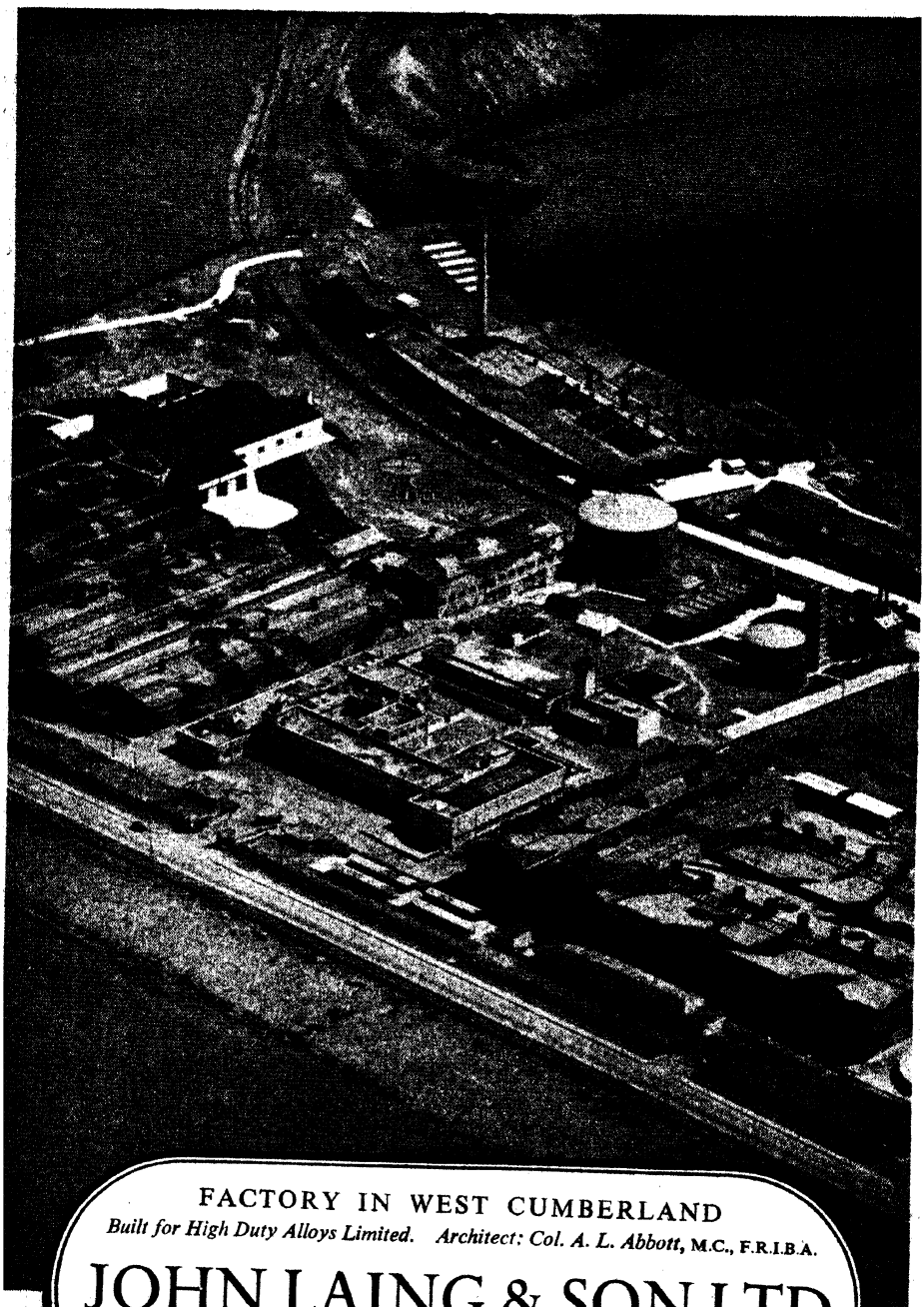
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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4736 *FRIDAY, JANUARY 31st, 1947* Vol. xcv

MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

Ordinary Meetings

Wednesday, February 5th, at 5 p.m. (*Peter Le Neve Foster Lecture*).—"The History and Aims of the Army Cadet Force". By Major-General R. E. Urquhart, C.B., D.S.O., lately Director, Territorial Army and Army Cadet Force. Major-General the Viscount Bridgeman, C.B., D.S.O., M.C., Chairman, Army Cadet Force Association, in the Chair.

Wednesday, February 12th, at 5 p.m.—"Economic Reconstruction"—(iii) "Materials". By F. A. Freeth, O.B.E., D.Sc., Ph.D., F.R.S., of Imperial Chemical Industries, Ltd. The Right Hon. John Wilmot, J.P., M.P., Minister of Supply, in the Chair. (Illustrated by lantern slides and specimens).

India and Burma Section

Thursday, February 6th, at 2.30 p.m.—"The Forests and Forest Resources of India". By Sir Herbert Howard, late Inspector-General of Forests to the Government of India, and President, Forest Research Institute. E. P. Stebbing, M.A., Professor of Forestry, Edinburgh University, in the Chair.

Cantor Lecture

Monday, February 3rd, at 5 p.m. (second lecture of two).—"Applications of Recent Physical Discoveries to Medical Diagnosis and Treatment". By A. Dickson Wright, M.S., M.B., F.R.C.S.

MEETING OF COUNCIL

A meeting of the Council was held on Monday, January 13th, 1947. Present: Viscount Bennett (in the Chair); Lord Aberconway; Mr. F. H. Andrews; Sir Frank Brown; Major W. H. Cadman; Sir Atul Chatterjee; Sir Edward Crowe; Mr. E. W. Goodale; Dr. R. W. Holland; Sir Harry Lindsay; Sir Henry McMahon; Mr. G. K. Menzies; Mr. J. A. Milne; Mr. Keith Murray; Mr. E. M. Rich; Mr. E. Munro Runtz; Captain A. H. Ryley; Viscount Samuel; Mr. William Will; Mr. J. G. Wilson, and Miss Anna Zinkeisen; with Mr. K. W. Luckhurst (Secretary) and Mr. C. Burns (Assistant Secretary).

The following were duly elected Fellows of the Society:

Abbott, Lionel, M.B.E., Walsall, Staffs.
Adams, John Henry Lewis, Rubery, Worcs.
Ashforth, George Ernest, C.B.E., Brook, Isle of Wight.
Atabay, Mehmet Ercument, M.A., Istanbul, Turkey.
Atkinson, Robert, London.
Averill, Charles William Stephen, Horsham, Sussex.
Bach, Stephen Crain Goulden, O.B.E., London.
Bailey, Alfred, M.Sc., Teddington, Middx.
Bennett, Sir Thomas Penberthy, C.B.E., London.
Birmingham University.
Boehm-Myro, Robert, London.
Bonn, Major Walter Basil Louis, D.S.O., M.C., Cirencester, Glos.
Braddock, Thomas, M.P., London.
Brazier, Leslie Giddens, B.Sc., PH.D., London.
Bruce, Robert, B.Sc., Glasgow.
Burt, Sir George Mowlem, London.
Cadbury, Paul Strangman, Birmingham.
Caplin, Abram Maxwell, Southport, Lancs.
Charlton, Lieut.-Colonel Richard Wingate Graham, Takeley, Essex.
Clark, George Geoffry, Wareham, Dorset.
Conybeare, Sir John Josias, K.B.E., M.C., London.
Cordingley, Reginald Annandale, M.A., Sale, Cheshire.
Cousland, Charles Johnstone, Edinburgh.
Crockett, Geoffrey Albert, B.A., London.
Curton, Arthur William, J.P., Edgware, Middx.
Dalton, Sir Robert William, C.M.G., London.
Davies, Max Emil, B.A., High Wycombe, Bucks.
de Burgh, General Sir Eric, K.C.B., O.B.E., D.S.O., Co. Kildare, Ireland.
Desai, Bhaskar Raojibhai, Leeds.
Fletcher, Lieut.-Colonel William Baldwin, Edgbaston, Birmingham.
Forman, Kenneth Phillip, Peakhurst, N.S.W., Australia.
Gallagher, Leonard Eugene, Orpington, Kent.
Greaves, George Methuen, Tunstall, Stoke-on-Trent, Staffs.
Hain, Henry William Theodore, B.Sc., C.B.E., Calcutta, India.
Hingorani, Miss Shakuntala R., London.
Hoad, Edward Horton Percival, Sevenoaks, Kent.
Hunter, Alec Butler, Thaxted, Essex.
Jennings, Edward Almond, London.
Jobey, Major Jack Reginald, Gillingham, Kent.
Kaur Jawala Singh, Mrs. Jogindar, B.A., Punjaub, India.
Kebbell, Miss Clara Ann, Stanmore, Middx.
Knight, Stephen Alfred, Wellingborough, Northants.
Leigh, Malomo Babatunde Olatunde, Lagos, Nigeria.
Loring, Major Norman, Colchester, Essex.
Millar, John, London.
Minta, Cyril Frederick, Bordon, Hants.
O'Hegarty, Patrick Joseph, Co. Wicklow, Ireland.
Oswald, Adrian Hugh, M.A., Westerham, Kent.
Paisley, Mrs. Mary, Toronto, Ont., Canada.
Parsons, Flight-Lieutenant Kenneth Noel James, Templecombe, Somerset.
Pike, Wyndham James, New Barking, Essex.
Taimuri, Dr. Mirza Hamid Raza, Bhopal, Central India.
Vezey, Douglas Dickinson, Batheaston, Bath.
Walls, Stanley King, Tenafly, N.J., U.S.A.
Wijeyesekera, Arthur Eugene Seneviratne, London.

Williams, James Emrys, London.
Williamson, William James, London.

The following were duly elected Associate Members of the Society:

Herzka, Alfred, London.
Jones, Trevor Russell, Talke, Stoke-on-Trent, Staffs.
Smith, Keith Pegden, Slough, Bucks.

Arrangements were discussed for the Conference on the proposed International Exhibition, convened by the Society, as reported in the *Journal* of January 17th, 1947.

A quantity of formal and official business was transacted.

CONFERENCE ON PROPOSED 1951 EXHIBITION

Arrangements are now well in hand for the Conference of representatives of organisations which has been convened by the Royal Society of Arts to discuss the question of the proposed 1951 Exhibition. The following organisations have, up to Monday, January 27th*, intimated their intention to be represented:

Institute of Actuaries (Mr. A. H. Rowell, President).
Anglo-Danish Society (Mrs. T. S. Vickery, Hon. Secretary).
Anglo-Hellenic League (Mr. P. J. Calvocoressi, Acting Chairman).
Anglo-Netherlands Society (Mr. Frank Beresford, Joint Hon. Secretary).
Central Institute of Art and Design (Mr. T. A. Fennemore, Secretary).
Association of Art Institutions (Mr. F. L. Freeman, Chairman).
Royal Academy of Arts (Sir Walter Lamb, Secretary).
Arts Council of Great Britain (Sir Ernest Pooley, Chairman).
Association of Assistant Mistresses (Miss O. M. Hastings, Secretary).
Automobile Association (Mr. H. Cecil Orr, Public Relations Officer).
Institution of Automobile Engineers.
Boys' Brigade (Mr. W. H. McVicker, Overseas Secretary).
Boy Scouts Association (Mr. A. W. Hurll, Pen Secretary).
British Association for the Advancement of Science (Mr. D. N. Lowe, Secretary).
Association of British Chambers of Commerce (Mr. John McLean).
British and Central European Chamber of Commerce (Mr. J. H. Goldman, Hon. Secretary).
British Council (Mr. B. Kennedy-Cooke, Director of the Production Division).
Incorporated Institute of British Decorators (Mr. H. G. Dowling, Past-President).
British and Latin American Chamber of Commerce (Sir Patrick Hannon, President).
Building Centre (Mr. F. R. Yerbury, Managing Director).
Society of Chemical Industry (Dr. L. E. Lampitt, President).
Royal Institute of Chemistry (Mr. H. J. T. Ellingham, Secretary).
Institution of Civil Engineers (Sir William T. Halcrow, President).
Chemical Society (Professor William Wardlaw, Senior Hon. Secretary).
Church Assembly (Prebendary Eley).
Commons, Open Spaces and Footpaths Preservation Society (Sir Lawrence Chubb, Secretary).
Congregational Union of England and Wales (Rev. E. C. D. Stanford).
Society for Cultural Relations with the U.S.S.R. (Miss Timbey).
Design and Industries Association (Lord Sempill, President).
East India Association (Sir John Woodhead, Chairman of Council).

* At the time of going to press, on Wednesday, January 29, a further fifteen organisations had notified their intention to be represented.

Electrical Association for Women (Dowager Lady Swaythling, President).
Institution of Electrical Engineers (Mr. D. B. Hoseason, Member of Council).
Franco-British Society (Mr. B. S. Townroe, Director).
Free Church Federal Council (Rev. D. Hubert Thomas, Asst. General Secretary).
Geological Society of London (Dr. David Williams, Secretary).
National Association of Girls' Clubs (Mrs. Walter Elliot, Chairman).
Headmasters' Conference (Mr. C. H. Gilkes).
Association of Head Mistresses (Miss F. A. West).
Housing Centre (Miss A. M. Lupton, Chairman of General Committee).
Hotels and Restaurants Association of Great Britain (Mr. Hugh Wontner, Member of Council).
Imperial Institute (Sir Harry Lindsay, Director).
Society of Industrial Artists (Mr. Milner Gray, President).
Council of Industrial Design (Mr. S. C. Leslie, Director).
Industrial Welfare Society (Mr. R. R. Hyde, Director).
Chartered Insurance Institute (Mr. H. A. L. Cockerell, Secretary).
Institute of Landscape Architects (Lady Allen of Hurtwood).
Library Association (Mr. W. B. Stevenson).
London Chamber of Commerce (Sir Frank Newson Smith).
London Society (Miss E. Bright Ashford, Organising Secretary).
University of London (Professor D. Hughes Parry, Vice-Chancellor).
Confederation of Management Associations (Mr. Reginald Pugh, Secretary)
National Union of Manufacturers (Sir Patrick Hannon, President).
Institution of Mechanical Engineers (Mr. O. V. Bulleid, President).
Royal Society of Medicine (Mr. Geoffrey Edwards, Secretary).
Metropolitan Public Gardens Association (Col. the Hon. G. K. Mason).
Museums Association (F. Lambert, President).
National Housing and Town Planning Council (Major John G. Martin, General Secretary).
Institution of Naval Architects (Dr. S. Livingston Smith).
Over-Seas League (Air Vice-Marshal Malcolm Henderson, Director-General).
Association for Planning and Regional Reconstruction (Miss J. Tyrwhitt, Director of Research).
Royal Aeronautical Society (Captain J. L. Pritchard, Secretary).
Royal African Society (Miss H. Heather, Assistant Secretary).
Royal Asiatic Society (Mr. J. H. Lindsay, Hon. Treasurer).
Royal Automobile Club (Mr. Wilfrid Andrews, Chairman).
Faculty of Royal Designers for Industry (Mr. Keith Murray, Master).
Royal Empire Society (The Earl of Clarendon, President).
Royal Horticultural Society (Lord Aberconway, President).
Royal India Society (Mr. F. Richter, Hon. Secretary).
Royal Institution (Colonel E. E. B. Mackintosh, Vice-President).
Royal Photographic Society (Mr. Percy W. Harris, Vice-President).
Royal Sanitary Institute (Dr. J. W. Dudley Robinson, Secretary).
Royal Society (Sir Robert Robertson).
Royal Society of Edinburgh (Sir Thomas Holland).
Incorporated Sales Managers' Association (Mr. H G. Saward).
Church of Scotland (Rev. Joseph Moffett, Clerk of the Presbytery of London).
Central Committee of Scottish Chambers of Commerce (Sir William Y. Darling, Chairman).
Chartered Institute of Secretaries (Mr. A. Gale Johnson, Vice-President).
National Council of Social Service (Mr. G. E. Haynes, Secretary).
Institution of Structural Engineers (Mr. Leslie Turner, Member of Council).
Royal Institution of Chartered Surveyors (Mr. John Watson).

Association of Teachers in Technical Institutions (Mr. C. Jameson, President).
National Chamber of Trade (Mr. W. Ellis Clibbon).
Institute of Transport (Mr. Evan Evans).
Travel Association (Mr. H. S. Hydes, General Manager and Secretary).
General Assembly of Unitarian and Free Christian Churches (Rev. Harold Baily, President).
United Nations Association.
National Council of Women of Great Britain (Mrs. Patrick Ness).
Women's Engineering Society (Miss J. F. Cooper, Secretary).
National Federation of Women's Institutes (Freda, Countess of Listowel).
Women's Voluntary Services (Lady Hillingdon, Vice-Chairman).
Works Management Association (Mr. A. P. Young, Chairman).
Young Men's Christian Association (Mr. R. W. Keeble).
The Archbishop of Westminster (by a representative).

WAR MEMORIALS ADVISORY COUNCIL

An Imperial War Memorial

On Wednesday, January 22nd, 1947, Admiral of the Fleet Lord Chatfield, President of the War Memorials Advisory Council, which was set up in 1944 as a result of a Conference convened by the Royal Society of Arts, moved the following Motion in the House of Lords:

> "To ask His Majesty's Government, whether they have given consideration to the desirability of erecting an Imperial War Memorial in London, to honour all who died in the two great wars for freedom; and to commemorate the spirit in which the peoples of the British Commonwealth and Empire went to war, and the cause for which they stood; whether they will take steps to ascertain the feelings of the British Commonwealth and Empire on this matter; and to move for Papers".

Lord Chatfield said: In moving my Motion to-day on the desirability of an Imperial War Memorial in London, my object is to draw the attention of His Majesty's Government to this important national question and to arouse public interest in it. If this can be achieved, then perhaps some more definite action may be taken by His Majesty's Government.

I am speaking not merely as an individual, but also as President of the War Memorials Advisory Council, a body which I brought to the attention of this House in February, 1945. I then pointed out the important composition of this Council, including, as it does, members of both Houses of Parliament and many other distinguished people, as well as fifty Societies, concerned with the arts, with architecture, the beautifying of the country and the happiness of its citizens. At that time, the work of the Council was limited to advising the cities and villages of the country on the problems of war memorials, but it supported, in principle, the idea of an Imperial or National War Memorial.

I mention this past action because since then, *i.e.*, in the last two years, a good deal of work has been done. Hundreds of local authorities, schools and other bodies have consulted us, and I think I can claim we have exerted a useful influence in the country.

About a year ago, the present Government had under its consideration the question of a central war memorial, and consulted the Council whether any public feeling in the matter had come to our notice. We replied that there had been little such expression; nor did we think there would be until a lead was given, but we recommended that some action should be taken and that any type of central memorial should be imperial rather than national. We further offered our full support. The President of the Council, Mr. Herbert Morrison, expressed his gratitude for our help. No action, however,

developed, other than the consideration of certain plans that had been put forward by individuals; and as I understand the situation, nothing more will be done, unless and until some national feeling on the subject develops. Feeling strongly, therefore, that some further steps should be taken, I have, with the unanimous support of my Council, moved my Motion to-day to endeavour to arouse interest throughout the country.

As all know, the Cenotaph in Whitehall has recently been re-dedicated to include "The Glorious Dead" of both wars. It is right this should have been done, for though to us the two wars are twenty-five years apart, time will close the gap until they are looked back on as one great struggle against evil. The Cenotaph means a great deal to us all, but particularly perhaps to the older generation; it is, like the Tomb of the Unknown Warrior, primarily connected with the fighting services. To me, for instance, it commemorates in particular those naval comrades who gave their lives at sea in the first war; it is a monument one passes with reverence and affection. But it does not perhaps convey as much inspiration to the younger generation, which has borne the broader strain of the second war. I believe they would feel something more should be done, and that feeling has certainly been shown in towns and villages, where, in most cases, new memorials of a beautiful and useful character have been decided on, rather than merely to re-dedicate the obelisk or other memorial structure erected twenty-five years ago.

Nor do we find the Commonwealth with any such limited view. Canada has decided specially to commemorate the second World War by the beautification of Ottawa and its surrounding area. South Africa is to do something "to express the realisation of the fundamental rights of all nations" by a great development of health services in many different ways. Australia, where the great structure commemorating the first war is nearing completion at a cost of £250,000, is to enlarge the building so as to further improve and beautify it. New Zealand and India are each to have a second War Memorial of some useful type.

Does not the inspiring story of our own efforts in the past six years cry out for some expression also? Have we not a just feeling of pride in our hearts, that we have proved equal to our great responsibilities and worthy of our great history? Have we not passed through a period which has been the highest test our national character has ever faced?

It is not alone the glorious dead of the fighting forces we must commemorate; we must remember all who died in the struggle—the men and women who fought the bombs and fires, our merchant seamen who kept the seas, those who died exhausted from war work, and thousands of others whose work is unrecorded and cannot be practically recognised. Nor is it the dead alone, but the living, whose faith and efforts should be perpetuated in the nation's memory.

But above all, it is the spirit in which we fought which we should primarily commemorate—the high ideals that inspired us, the struggle against evil; the national hatred of war which led us to cling to a hope that by moral influences, such as through the "League", the evil-minded might be checked; our consequent unreadiness for war, and yet we gave the guarantee to Poland and Roumania in 1939. It was given because of the moral indignation of the British race, that would not allow us any longer to stand aside when wrong was being done to others by the dictators. *That* was the cause of our going to war.

When disasters came, we fought on alone, and by doing so saved the world from the worse fate that might have befallen it. Finally, with our Allies, who slowly joined us, we conquered. How have we used that victory—selfishly, to enrich ourselves, to add to our territories? Rather have we sacrificed our wealth and now have to work harder to keep our standard of living and feed and help our enemies. All these things are well known, but they will be forgotten, and many historians will ignore them. They record what may be called the spiritual nature of our fight.

But there are other things a memorial should rightly commemorate: the sacrifices made by a united nation in accomplishing our purpose; our resolution not to falter; our immense efforts to arm ourselves; the heroic determination of our youth in the

world's battlefields fighting for a cause in which they believed; the inspiration of men, women and children in these islands, so that they met every call of their leaders, however impracticable seemed the task, however severe the toil, however bitter the sacrifice, in complete unity of purpose. It is a chapter in our history which should ever be an inspiration to the British race, and must not be allowed to pass from mind in the turmoil of national life. We need permanently to recall these years of national honour.

What then do I suggest His Majesty's Government should do? I ask that they will give this proposal their sympathy and support, that they should offer to help its achievement and in such way as is possible to bring it to public notice. That when sufficient publicity has been achieved, and the public reaction develops, to invite the Lords Lieutenant, the Lord Mayors and Mayors to report the feelings of those they lead. Should the national response be favourable, to set up a suitable committee to consider ways and means and the type of memorial best suited for the enduring purpose I have stated.

As regards the type of memorial, many suggestions have been made. My personal views I gave in this House two years ago: a beautifully laid-out space in London with a shrine, conveying to posterity by its beauty and nobility the spiritual nature of our struggle and the sacrifices we willingly made to accomplish our task.

As to cost, I feel strongly it should be borne by voluntary subscription, though much might be given in kind. The permanent upkeep of the memorial should be financially assured, so that it will ever remain a thing of beauty that the world will visit and honour.

How can such a memorial fail to be Imperial in nature? The nations of the Empire not only fought with us, but in every way shared our spirit. I suggest the Government should ascertain the reaction of the Commonwealth and Empire to the matter. It is not necessary to appeal to them for financial support—rather might any share of the Empire in such a memorial be gratefully received in kind, of wood or stone, of trees or plants, typical of the Empire and suited to our climate.

Finally, let us in this great city create something beautiful which will balance the great commercial structures of utilitarian purpose with which London abounds. Let us show ourselves and posterity that in this materialistic age we believe in the pre-eminence of things spiritual and that those who are high in spirit can achieve everything.

I believe that those who gave their lives in the years of struggle would wish that our memorial should commemorate not so much themselves, still less the victory, but above all things be a tribute to the high ideal which inspired their sacrifice.

Such a memorial will not be built in a day, but do not let us expect our children to build it for us. It is for us to seize the great opportunity that lies before us, to place the first stone, to ensure the memorial is designed and built in the right spirit, and so bequeath an inspiration to posterity.

The EARL OF ROSEBERY, speaking in the absence of the Earl of Crawford, President of the Scottish War Memorials Advisory Council, said that Scotland had Edinburgh Castle by which to remember the first World War, and if there was a desire for a second memorial, no doubt Stirling Castle could be considered. As for an Empire memorial in London, his own view was that the money would be better spent in helping the living rather than erecting a memorial to the dead.

Field-Marshal Lord CHETWODE, in supporting the Motion, suggested that part of the south bank of the Thames, say a few hundred yards from the County Hall down to the new bridge, should be used for the purpose of erecting a national, or Imperial, memorial.

Viscount BRIDGEMAN expressed entire agreement with the Motion, and asked that, in working out any scheme for such a memorial, the machinery and services of the Imperial War Graves Commission should not be overlooked by the Government.

The EARL OF PERTH, referring to Lord Rosebery's remarks, mentioned the restoration of the chapel at Holyrood as a possible memorial for Scotland.

Viscount HALL (First Lord of the Admiralty), replying for the Government, said: The Government are grateful to Lord Chatfield for initiating the present debate, since the subject is one of great national interest. I am anxious at once to reassure this House that His Majesty's Government share to the full the feelings and sentiments which have been so movingly and ably expressed. No praise is too great, and no memorial, whatever its form or cost, is sufficient to indicate the full appreciation of the Commonwealth for the great sacrifices of the dead and the living—service and civilian. I am sure that those great sacrifices and that service will be regarded for all time as a noble example and an inspiration for all who are to follow.

Lord Chatfield referred to the inscription which has been placed on the Cenotaph. This inscription, appropriately, now commemorates those who fought and died for freedom in the last two wars. When it was first erected, and, indeed, at the present time, the simple beauty of the Cenotaph kindled the imagination of the whole Empire, and it has remained a lasting source of inspiration and remembrance. I am confident that you will agree fully with me when I say that nothing should be done to detract from the value of, and the general feelings of the people to, this symbol, which is still the scene of our annual pilgrimage in homage of those who fell in the Great War of 1914–18 and, as was indicated by the numbers of those who attended at the last celebration thereof, of those who similarly fell in the recent war.

Then there has been after the recent war, as after the war of 1914–18, a spontaneous movement for local memorials of one kind or another, not only in this country but in the Dominions and the Colonies as well. Local memorials, by virtue of their close association with the dead and their relatives and friends, make an appeal of a kind with which no memorial on a wider scale can compete. In this connection the Government, and indeed the people of this country, are deeply indebted to the War Memorials Advisory Council, of which Lord Chatfield, is the distinguished President, and to the Scottish Advisory Council, for the sound guidance they have given to local authorities and others who are planning war memorials. The booklets indicating suitable forms of memorials which were prepared by these bodies have done a great deal to direct local initiative along the right lines.

Then, apart from these local memorials, we have the memorials which have been, or will be, erected in schools, by industrial firms and associations of all kinds. They too preserve the memory of the sacrifices which were made by those who gave their lives in the war. As in the war of 1914–18, service memorials are being erected both in this country and on the site of hard-fought engagements. In this connection His Majesty's Government are indebted to the continued assistance which the Imperial War Graves Commission has afforded. I would like to convey to the Imperial War Graves Commission a full appreciation of what they have done, and to assure Lord Bridgeman that if His Majesty's Government at any time initiate or take part in any scheme, the Imperial War Graves Commission will, of course, be kept in very close consultation.

The question which we have been discussing this afternoon is whether all these particular memorials and the Cenotaph should be supplemented by some more general memorial erected in London to honour all from the Commonwealth and Empire who died in the two Great Wars for freedom, and to commemorate the spirit in which the peoples of the British Commonwealth and Empire went to war and the cause for which they stood. No such memorial was erected after the last war. I mention this as a fact, rather than as an argument one way or another. But much would depend on the form which an Imperial War Memorial might take. It must commend itself to all the various races and creeds of the Empire and also meet a need which is not already covered by existing memorials.

His Majesty's Government are not aware of any representations so far, from either the Dominions or the Colonies, that any modification should be made of the conclusion which was reached at the end of the 1914–18 war. Some of them are proceeding with their own form of national memorial, as was outlined by Lord Chatfield, in the course of his speech. As I have indicated, had indeed any such view been expressed, much would

depend on the form which an Imperial War Memorial could take. In the course of speeches this afternoon three different forms were suggested, which indicates that it would not be easy to find another form of memorial, tangible or intangible, which could be regarded as honouring all who died in the two Great Wars, and, at the same time, commemorating the spirit in which the peoples of the British Commonwealth and Empire entered into conflict and the cause for which they stood. It may, in fact, be that no physical memorial could be created which would do full justice to so tremendous a theme and fully reflect the story and tragedy of the two World Wars.

The suggestion that there should be a National War Memorial has been before the country since October, 1944, when the War Memorials Advisory Council published a suggestion, made at a War Memorials Conference summoned by the Royal Society of Arts, which supported in principle that there should be a National War Memorial in London. You will be aware from the speech which Lord Chatfield delivered in this House on February 14th, 1945, that the Survey published by the War Memorials Advisory Council which included this suggestion was given a wide circulation. It would be interesting to know whether any response was evoked from the authorities to whom the Survey was sent. So far as His Majesty's Government are aware, there has been no response to the suggestion, nor have there been framed individual schemes which have fired the imagination of the nation and created a demand for a National or Imperial Memorial.

In the absence of specific projects likely to make a national or an Empire-wide appeal, His Majesty's Government do not at present see the way clear to consult at this stage the Dominions, India and the Colonies on the lines suggested in this Motion. All that is good and enduring in this difficult post-war world is in a very real sense a monument to the sacrifices made by the dead and the living in the two great conflicts we have come through. Whether we can and should attempt to give tangible form to our feelings is a difficult question on which the Government have taken no decision; but they are of the opinion that no scheme has so far been put forward which is adequate for the purpose.

If at any time an expression of public opinion of sufficient magnitude to warrant further consideration of this matter should emerge, together with a scheme which could be regarded as a suitable National War Memorial, His Majesty's Government would then be prepared to give further thought to the question. I regret that it is impossible to accept the Motion in the form in which it is on the Paper, but I can assure you that His Majesty's Government will give very careful consideration to the points which have been raised in all speeches.

Lord STRABOLGI regretted Viscount Hall's reply and thought it was a matter for the Government to give a lead in the matter of a national or Imperial memorial, and not to wait for public opinion to manifest itself. A great opportunity had been lost after the First World War of putting up a worthy monument, and another would be lost now if action was not taken soon.

Lord ALTRINCHAM also expressed his disappointment with the Government's reply, and hoped that the suggestion to build a new cloister of Westminster Abbey might be revived.

Admiral of the Fleet Lord CHATFIELD, in withdrawing his Motion, felt that the issue had been somewhat confused between the principle of whether there should be a memorial, and what form it should take. The two things were entirely separate, and it should first of all be decided whether a memorial was wanted or not. He was certain that something would eventually come of the matter, and that even if nothing were done now, posterity would undoubtedly erect a memorial one day in gratitude for what had been done for them.

ECONOMIC RECONSTRUCTION

(I) GREAT BRITAIN IN RELATION TO THE WORLD'S TRADE SITUATION

By Sir CHARLES LIDBURY

Chief General Manager, Westminster Bank, Ltd.

Seventh Ordinary Meeting, Wednesday, January 15th, 1947

Mr. E. M. RUNTZ, *Treasurer of the Society, in the Chair*

THE CHAIRMAN: Our President, Lord Bennett, had hoped to take the chair this evening, but he has unfortunately had to leave London, acting on doctor's orders. We shall all miss his genial and authoritative presence.

The subject of the paper this evening should be of great interest to us all, partly, I think, owing to our present inability to purchase consumer goods, either of our own or of foreign production. Indeed, in this respect I always carry a few clothing coupons about with me lest the worst should happen and the flimsy materials which cover me should fail! The paper Sir Charles Lidbury will read is the first of a series on the subject of Economic Reconstruction; and it would be difficult to find a lecturer more competent to speak on such a subject, for he is recognised as a great authority on all matters of finance and commerce, not only in London, but throughout the country.

Sir CHARLES LIDBURY then read the following paper:

INTRODUCTORY

This evening's paper is, as you know, the first of a series on "Economic Reconstruction". That is a topic which is very much in people's minds to-day. We are all agreed that reconstruction is necessary, but are we all equally agreed on what it is that needs reconstructing? It is important, I think, to be clear on this point from the outset. Is our slogan to be "Back to 1939"? I hope not. I do not think that any sane person would wish for a return to the uneasy state of suspended hostility which prevailed between the two wars, with all the dire effects which that state of affairs had on our economic life. In any case such a return is impossible. You cannot put the clock back in these matters. The economic organisation of a country grows and develops continuously—sometimes slowly—sometimes quickly. We can observe that growth; we can attempt to understand it and perhaps to forestall it; we can try to guide its direction, or should I say we can watch other people, at Whitehall, for example, trying to guide its direction; but we can never call a halt or go back to a given point.

What, then, for our purpose, does reconstruction mean? Firstly, I think you will agree, restoration of our standard of living to something like a decent level. We want to see satisfactory standards of nourishment, clothing and housing and an end of rationing as soon as may be. Secondly, we want to build up for the future a general state of sound, well-balanced economic activity, not only in Great Britain, but in the world at large, so that the nations may develop their resources to the full and to the advantage of all. That is no small undertaking. But will anything less serve to compensate us for the years of costly and painful striving from which we are emerging? Will anything less encourage us to look to the future with hope and confidence?

Other lecturers in this series will deal with particular aspects of this problem as

it affects the commerce and industry of this country. It is fitting that the present lecture, the first of the series, should be devoted to the matter most vital to Great Britain, upon which, one may say, the solution of all her other problems depends, namely, our overseas trade in relation to world trade.

Meaning and Purpose of International Trade

At the basis of international trade lie certain unalterable geographical facts. It is not by accident that the prairies of Canada, for example, produce a huge surplus of grain; that the natural grasslands of the Argentine supply the world with beef; or that Lancashire looked to the Southern States of North America for supplies of raw cotton. The climate of a country, the nature of the soil, the natural means of communication, and the occurrence of mineral deposits—all these are prime factors in determining the shape of productive activity. No less important are the size and distribution of the population and its stage of development. Some of these features are permanent and unchangeable. Others change very slowly. But it is the fact that they vary from one country to another that explains the diversity of characteristic products which the various countries have to offer.

Trade is the means whereby the division of labour between the nations of the world—international specialisation, if you prefer it—can be intensified. Each country tends to produce the things best suited to its circumstances. The advantages of such a system are very substantial. It means that the factors of production are more efficiently employed than if the nations attempted to be economically self-sufficient. Perhaps we *could* grow our own bananas and pineapples in the United Kingdom. No doubt they do it at Kew. But it could only be done at a ruinous cost. And that is precisely what economic self-sufficiency means—higher costs and lower standards of living.

Importance to Great Britain of Foreign Trade

There is probably no country in the world which has a greater interest in this principle of international specialisation and the international trade which results from it than our own. We have no adequate home supply of any important raw material except coal. These islands are small and densely populated. Our own agriculture cannot produce sufficient food for our needs. To us trade is not a luxury, it is a necessity. In earlier times this was not the case. This country was once peopled by a small and chiefly agrarian population. Our merchant adventurers set out for the East Indies in search of spices, silks and objects of artistic value. To-day trade is a question of providing not luxuries but our daily bread.

Let us consider food first of all. Before the war we depended on imports for more than half our food.[1] Over half the meat we eat, nearly all the fats we consume, four-fifths of the sugar and nine-tenths of the cereals and flour we use were imported. So far as such items as tea, coffee, cocoa and tobacco were concerned—and these are, you will agree, not entirely unimportant—we are, of course, wholly dependent upon imports. In addition, large quantities of animal feeding stuffs were imported in normal times for the maintenance of the domestic production of meat, bacon and dairy produce. As we all know, we reduced imports of food by 50 per cent. during the war only by managing with less of the things we wanted, by

TABLE 1—PRE-WAR FOOD CONSUMPTION IN THE UNITED KINGDOM SHOWING THE PERCENTAGES HOME-PRODUCED AND IMPORTED

Commodity Group	Annual Average 1934–38		
	Total thousand tons	Percentage Home-produced (*a*)	Percentage imported
Flour from wheat and other cereal products	4,428	12	88
Fats (butter, lard, margarine)	905	7	93
Sugar	2,184	18	82
Meat (including bacon)	2,707	45	55
Fish (including canned) (edible weight)	523	85	15
Eggs and egg products	500	60	40
Milk (liquid)	4,579	100	—
Condensed milk	260	70	30
Dried milk	35	61	39
Cheese	185	24	76
Potatoes	3,700	94	6
Other vegetables	2,715	92	8
Fruit (including tomatoes)	2,406	26	74

(*a*) Partly dependent on imported feeding stuffs.

TABLE 2—REDUCTION IN FOOD IMPORTS DURING THE WAR

United Kingdom Imports of Food and Animal Feeding Stuffs (excluding unrefined Whale Oil and identifiable Imports from Eire)

	Thousand tons
Average—1934–38	22,026
1940	18,834
1941	14,654
1942	10,606
1943	11,525
1944	11,032

Ministry of Food Pamphlet, *How Britain was Fed in Wartime*. H.M. Stationery Office, 1946.

switching to less palatable and less nourishing food, and by cutting imports of animal feeding stuffs almost to zero. These and other expedients meant a more monotonous and less satisfying diet.

So much for food. As regards raw materials,[2] coal is the only one in which we are, or should I say we hope we are, self-supporting.[3] All our cotton, nine-tenths of our wool, a third of our iron-ore, most of our timber and all the natural rubber—all these come from overseas. As for manufactured and semi-manufactured goods, these items amounted in peace-time to about one-fifth of our total imports by value.[4]

I think this evidence is sufficient to indicate the extent to which even in so-called normal times we are dependent upon imported goods. We shall consider later how much greater this dependence is at the present when trade is so far from normal. But there is another way in which our national well-being is linked with foreign trade. I refer to the large number of workers who are engaged in the export trades. These trades found employment for 1¾ millions before the war.[5] Consequently, the volume of employment in this country depends very largely on the state of our external commerce.

Closely connected with foreign trade and of no small importance to this country are the services of our shipping. Owning as we did before the war over a quarter of the world's total tonnage,[6] we were able to earn a substantial sum in freights for our services as carriers of cargoes in all parts of the world. These earnings were of the order of £100 millions per annum,[7] varying a good deal from year to year, according to the state of world trade. A smaller item, normally yielding £35 to £40 millions per annum, is provided by commissions, insurance premiums, etc., most of which arise out of foreign trade. These are, of course, "invisible" items. That is to say, the rest of the world has to pay us that amount just as if we had sent them merchandise to the same value. So we call them "invisible exports". They helped us quite a lot to square our balance of payments. But as I shall have a good deal to say about the balance of payments a little later I shall say no more about it just now.

I think I have said enough to demonstrate that the importance of foreign trade to this country cannot be stressed too strongly.

Deterioration of the Position of Great Britain as an Exporting Country

We shall understand Great Britain's position better if we take a glance at the past and see how the present situation arose. The story of our country's spectacular rise to pre-eminence among the trading nations of the world is a familiar one. It was by virtue of an early start along the path of industrialisation and free trade that this proud position was achieved. And the underlying factor which made this development possible was an ample supply of coal, which was both the foundation of

Table 3—Tonnage Owned in the United Kingdom compared with World Tonnage

Steam and Motor Vessels (excluding U.S. Tonnage on the Great Lakes)

	U.K.	World	U.K. as % of World
	Gross tonnage, thousands	Gross tonnage, thousands	%
1905	14,497	28,743	50·4
1915	19,236	43,498	44·2
1925	19,305	60,103	32·1
1935	17,298	61,247	28·2
1945*	14,000	77,700	18·0

*Approximate figures only.
Reproduced from the *Annual Report for* 1945–46 *of the Chamber of Shipping of the United Kingdom.*

TABLE 4—INCOME FROM SHIPPING AND OTHER INVISIBLE EXPORTS

Balances of Credits and Debits in the Transactions (other than the Lending and Repayment of Capital) between the United Kingdom and all other Countries

Particulars	1936	1937	1938
	In million £'s		
Excess of imports of merchandise and silver bullion and specie	345	442	377
Estimated excess of Government payments made overseas	3	4	13
Total	348	446	390
Estimated net national shipping income*	85	130	100
Estimated net income from oversea investments	200	210	200
Estimated net receipts from commissions, insurance, etc.	35	40	35
Estimated net receipts from other sources	10	10	—
Total	330	390	335
Estimated total debit balance on items specified above	—18	—56	—55

*Including disbursements by foreign ships in United Kingdom ports.
Reproduced from *Board of Trade Journal*, February 23rd, 1939.

industry at home and an important item in overseas trade. In the nineteenth century, that golden age for British commerce, there was an unlimited demand for all the things we were so well able to supply—coal, iron, cheap textiles, machinery and manufactured goods of all kinds. What was equally important was that we were ready to take the food and raw materials which the "new" countries had to offer. The rapid opening-up of the New World would otherwise have scarcely been possible in the circumstances of the time.

At the height of her supremacy Great Britain led not only in volume of manufacturing production, but also in volume of external trade. How, in the closing years of the old century and the early years of the new, she lost ground to her two keenest rivals, the United States and Germany, is also an old story. The First World War accelerated her relative decline, and the economic upheavals of the nineteen-twenties and thirties continued the process. Consequently, in the years preceding the Second World War, Great Britain accounted for only 9 per cent. of the world total[8] of manufacturing production (as against over 31 per cent. in 1870), and was scarcely able to maintain her lead in volume of external trade.

We can point to three main causes of this decline. The first was the spread of industrialisation abroad. Naturally, other countries were not content to rely permanently on this country for manufactured goods. The second cause was the decline in the importance of coal as an object of world trade. Other countries developed their coal deposits, so that many former markets were lost to the British exporter. Not only this, but coal was increasingly replaced by other sources of

TABLE 5—DISTRIBUTION OF THE WORLD'S MANUFACTURING PRODUCTION

Percentage Distribution of the World's Manufacturing Production

Period	United States	Germany	United Kingdom	France	Russia
1870	23·3	13·2	31·8	10·3	3·7
1881–85 ..	28·6	13·9	26·6	8·6	3·4
1896–1900 ..	30·1	16·6	19·5	7·1	5·0
1906–10 ..	35·3	15·9	14·7	6·4	5·0
1913	35·8	15·7	14·0	6·4	5·5
1913(*a*) ..	35·8	14·3	14·1	7 0	4·4(*b*)
1926–29 ..	42·2	11·6	9·4	6·6	4·3(*b*)
1936–38 ..	32·2	10·7	9·2	4·5	18·5(*b*)

(*a*) The second line for 1913 represents the distribution according to the frontiers established after the 1914–18 war
(*b*) U.S.S.R.
From *Industrialisation and Foreign Trade*. League of Nations, 1945.

power—oil and hydro-electric energy. The third adverse factor was the commercial policies adopted abroad. Other countries followed our lead in the development of their industries: they did not follow us in the adoption of Free Trade. In most countries new industries grew up behind protective tariff walls. It was not just a question of competition on equal terms. British exports were encountering the opposition of protective commercial policies.

The *relative* decline of this country was not of course necessarily a serious matter for our national economy. The adverse factors which I have described had their due effect, but nevertheless, in the years preceding the First World War our foreign trade was in a healthy condition and our continued prosperity seemed assured.

If we look at the balance of payments for 1913[9] we see that so far as the import and export of merchandise were concerned we had an adverse balance of £134 millions. But invisible items on the credit side amounting in all to £341 millions were sufficient to meet this deficit and leave a respectable credit balance of £207 millions. That was the sum which foreign countries owed us on the year's trading. What became of this amount? Well, we did not collect it there and then; the foreign countries retained it, in effect, in the form of loans from this country. Let me add that such loans were not of course made by the British Government. They were floated on the London capital market by bankers and taken up by private investors. The whole of this complicated business was sorted out and reconciled by the operation of supply and demand in free markets—the institutions which some people are so anxious to sweep into the dust bin.

But why all this talk about the balance of payments? Does it really matter whether it balances or not? The answer is—and it cannot be too strongly emphasised—that the balance of payments is only another way of saying that imports must be paid for by exports. Unless we can raise a loan, there is no other way of paying for them. If we pay with gold—that is only another export. If we fail to pay our way in this manner our currency depreciates and in the end no one will send us any more imports. It is just like bankruptcy in the case of an individual.

TABLE 6—BALANCE OF PAYMENTS
(in £ millions)

Year	External Trade			Invisible Income from all sources (adjusted for Silver movements and Government Overseas Receipts and Payments)	Net Balances of Payments on Income Account	
	Retained Imports	Exports of U.K. Produce and Manufactures	Excess of Imports		Favourable	Adverse
1907 ..	554	426	128	281	153	—
1910 ..	574	430	144	312	168	—
1913 ..	659	525	134	341	207	—
1920 ..	1,710	1,334	376	597	221	—
1921 ..	978	708	275	(Not available)		
1922 ..	899	720	179	323	144	—
1923(*a*) ..	978	767	211	351	140	—
1924 ..	1,137	801	336	408	72	—
1925 ..	1,167	773	394	438	44	—
1926 ..	1,116	653	463	449	—	14
1927 ..	1,096	709	387	469	82	—
1928 ..	1,075	724	351	474	123	—
1929 ..	1,111	729	382	484	102	—
1930 ..	957	571	386	414	28	—
1931 ..	797	391	407	304	—	103
1932 ..	651	365	286	234	—	52
1933 ..	626	368	258	258	—	—
1934 ..	680	396	284	277	—	7
1935 ..	700	425	275	307	32	—
1936 ..	787	441	346	328	—	18
1937 ..	954	521	433	376	—	57
1938 ..	859	471	388	333	—	55
1939 ..	840(*b*)	439	401			
1940 ..	1,126(*b*)	411	715			
1941 ..	1,132(*b*)	365	767			
1942 ..	991(*c*)	271	720	(Not available)		
1943 ..	1,226(*c*)	233	993			
1944 ..	1,291(*c*)	266	1,025			
1945 ..	1,051(*c*)	396	655			

(*a*) From April 1st, 1923, particulars relating to Imports and Exports include the trade of Great Britain and Northern Ireland with the Irish Free State (Eire).

From the same date the direct foreign trade of the Irish Free State (Eire) has been excluded.

(*b*) Includes munitions.

(*c*) Excludes munitions.

Reproduced from Statistical Appendix to Sir Charles Lidbury's Inaugural Address as President of the Institute of Bankers, October 4th, 1945.

In 1913, then, we had a respectable credit balance. Other countries were more anxious to have our goods than we were to have theirs. When we look at the figures for the period between the wars, however, and especially the nineteen-thirties, it is a very different story. The credit balance had dwindled until we started to show regularly not a credit but a debit balance which in 1936, 1937 and 1938 amounted to £18 millions, £57 millions and £55 millions respectively.[9] What had brought this about? It was the continued operation of the adverse tendencies I have described: the growth of industrialisation abroad, the decline of coal, the decay of Free Trade, all greatly aggravated by the First World War. Between 1913 and 1938 the value of our exports, so far from increasing, had actually declined from £525 millions to £471 millions (and this takes no account of the rise in prices). The reductions were most striking in the cheap goods which were traditionally regarded as the backbone of our commerce, and these reductions had not been balanced by any comparable expansion of alternative exports. This is significant. Have we already stumbled on a possible clue to our present difficulties? We must return to this point later. At the moment it is my object to demonstrate that even in 1939 a problem existed which would have been sufficiently grave had the peace been preserved. We were not paying our way. It is the root problem of which we must not lose sight when we are considering the more immediate difficulties with which we are faced as a result of the Second World War.

Distorting Effect of War and Political Considerations of Structure of World Trade

It is hardly necessary for me to stress the lamentable effects that war inevitably has on the structure of world trade. Agricultural lands laid waste, industrial areas devastated, populations impoverished and demoralised—all these strike at the very root of commerce. The illusions of prosperity which the exceptional demand for war supplies may produce here and there are illusions indeed. The world cannot fail to be in every way poorer for such destruction and waste of man-power, effort and material.

War and the fear of war give rise to crazy policies of national self-sufficiency in the vain search for security. These "guns or butter" policies are the very negation of the principle of international division of labour. Mushroom industries spring up in response to urgent and unexpected demands—the synthetic rubber industry in the United States is a classic example—without regard either to considerations of comparative cost, or to the future of such undertakings when the war is over.

My immediate purpose is, however, to show that apart from the more obvious consequences, war and the fear of war operate particularly to the permanent disadvantage of the commerce of this country. You will find that all the unsatisfactory tendencies which I have described are greatly aggravated by war. I spoke of the development of rival industries abroad. It is clear that when our own industrial resources are diverted to war purposes, other countries will fill the gap with their own production. I spoke of tariff barriers. It is obvious that countries which fear war and are preparing for it will be all the more anxious to protect vital industries by this method. I spoke of the decline of coal. It is equally clear that war produces a spate of technical developments and the search for more efficient sources of power is intensified.

During the Second World War, so far from continuing our efforts to increase the volume of our exports, we allowed our export trade to languish, partly of sheer necessity and partly by intention. By doing so, of course, we made a resumption all the harder. Finally, as if all this were not enough, we dug deep into our foreign assets and incurred crippling debts and so not only sacrificed future "invisible" income, but burdened ourselves with future "invisible" outgoings. The consequences of all this for our balance of payments was as if several decades of deterioration had been crowded into a few years.

Our commercial exports fell in 1944 to 30 per cent. of the 1938 total by volume —in value from £471 millions to £258 millions. The total of our overseas debt increased from £760 millions in 1938 to £3,355 millions in 1945. We realised £1,118 millions from the sale of overseas assets.[10] The value of what remains is not known, but is being calculated by the Bank of England Statistical Department.

As for the balance of payments, I have mentioned that in 1938 there was a deficit of £55 millions. It is not possible to base satisfactory conclusions on such trade statistics as are available for the war years, owing to the complications of Lend-Lease, etc., and the Board of Trade have not published figures for the balance of payments in respect of those years. But for 1946 an estimated deficit of no less than £750 millions was officially forecast. Speculative calculations during the year, based on the actual monthly trade figures, have suggested the lower figure of some £400 millions,[11] but, even so, it is a staggering deficit.

Britain's Short-Term Problem—The Restoration of her Standard of Living

These figures make clear the urgent nature of the immediate problem with which our country is faced, namely, how in our altered circumstances we can ensure a sufficient flow of imports to maintain our standard of living, and, if possible, to raise it to something like the pre-war level.

This is the problem behind the "export drive" of which we have heard so much. It must be solved if we are to see an end of rationing and shortages. According to the Board of Trade[12] we need to increase the volume of our exports by 75 per cent. above the pre-war level in order to maintain the same volume of imports. Indeed, we need a greater volume of imports, because if we are to export more goods we must have more raw materials. We shall have to contend with certain difficulties, some of which we may hope are only temporary. Among these is the all-round shortage of labour, partly attributable to our military commitments. Then there is the problem of Germany, which represents a considerable strain on our resources. On the other side of the picture we have a very tangible advantage in the shape of the American and Canadian loans. These loans ease matters just where the shoe pinches most: it is dollar exchange we need. But of course they will not last for ever, and we shall have to find dollars for the payments of interest and capital which commence in 1951. Another temporary advantage is the existence of a seller's market. The whole world has arrears of supply and replacement to make up, and, for the time being, there is an unlimited demand for goods of all kinds. *Production* is therefore the difficulty rather than competition. We shall not always enjoy this advantage, but we welcome it while it lasts. As it diminishes we must hope for an increase in the total volume of world trade. It has been pointed out[12] that an increase of 75 per cent.

in our exports would raise our share of the total of world trade to 35 per cent., if that total remained at the 1938 figure. It is hardly to be hoped that we could achieve such a proportion as that. We have therefore a strong interest in the steady and orderly expansion of world trade as a whole and not simply of our own.

But vital as the export drive undoubtedly is, and right as we are in concentrating our immediate attention upon it, we must not make the error of thinking that all we need is a short spurt to recover our position in the race, and that thereafter we can carry on at a steady trot. The testing time will come later when we shall have to maintain our position in the face of renewed competition. By that time it is to be hoped that we shall have achieved such a reorganisation of our production that we shall be able to find and retain our proper place in the general scheme of world trade.

BRITAIN'S LONG-TERM PROBLEM—FITTING HER OVERSEAS TRADE INTO THE FUTURE PATTERN OF WORLD TRADE

What is the pattern of world trade to be in the future? For some time now we have had before us a blue-print, as it were, of a scheme for world trade. It is chiefly an American blue-print, but it has already met with general approval elsewhere. I refer to the Bretton Woods Agreement and the proposed International Trade Organisation. The first of these deals with the finance of trade, and the second with the commodity side. Let us look at the financial question first. Rates of exchange are, of course, important things to the importer and exporter. They must know what imports will cost, and what exports will fetch. Once these rates of exchange are established, however that is done, they do not vary very much, apart from purely temporary day-to-day fluctuations, so long as the balance of payments is satisfactory. But if, for example, a country persistently imports more than it exports, and fails to secure a loan to fill the gap, then its currency will depreciate abroad.

In former times we had the international gold standard to regulate these matters. An outflow of gold was both a warning that the balance of payments was in an unsatisfactory state, and, at the same time, it was a means of rectifying the matter. What mechanism does the Bretton Woods scheme[13] set up for this purpose? In the first place it establishes an International Monetary Fund, formed by contributions from the member countries. The contributious are made partly in gold and partly in the respective currencies. The par values of the currencies are, in general, based on the rates of exchange ruling at the inception of the scheme. The object of the Fund is to assist in smoothing out temporary fluctuations in the rates of exchange by supplying currencies from the common pool to member countries as required. In this way the Fund will serve as a cushion to take the first shock of a sudden change in values. There are provisions for changing the basic par values, but it is intended that this should be done only as an exceptional matter.

Included in the Bretton Woods scheme is another institution, the International Bank for Reconstruction and Development. This establishment will be concerned with the negotiation of international loans, which are very necessary to world trade. Loans will be arranged either between one country and another, or direct from the Bank's own capital, which is also subscribed by the member governments. The Bank will give its guarantee where required, and will generally facilitate the granting

of such loans as are necessary for reconstruction in the "old" countries or development in the "new".

These financial proposals seem satisfactory enough as far as they go, but unless there is a solid basis of international trade underlying them, and unless the various countries succeed, on the whole, in balancing their overseas payments, the mechanism of itself cannot achieve very much. It is rather like the governor of an engine, which can speed the engine up or slow it down, but is quite useless when the engine stops for want of fuel.

It was a realisation of this fact, no doubt, that prompted the idea of an International Trade Organisation. Here again, the Americans came forward with cut-and-dried proposals, which they submitted to the preliminary Conference held last autumn. The United States Government favours an early reduction of tariffs, preferences and all other artificial barriers to trade.[14] In other words, they want greater freedom of trade and their proposals contain a detailed plan for bringing this about.

Now it is impossible in this lecture to go into all the details of these various proposals. It would require not one lecture, but many. I will draw your attention to one point which may very well be the crucial point. All the proposals clearly envisage multilateral trade. They are expressly designed to promote trade between all the nations on equal terms without tariffs, preferences, bilateral agreements or other hindrances. Now multilateral trade, if it is genuinely multilateral, is a very good thing. It is probably the best way to secure the greatest possible degree of international specialisation and so to get the most out of the world's resources. But multilateral trade implies that the nations must, roughly speaking, balance imports by exports, or get or grant loans to cover the difference. Its success depends on how far this is possible. Great Britain approaches the question with certain previous commitments in the form of Imperial Preference, but with a strong traditional bias in favour of Free Trade. But everything seems to depend on the United States, the sponsors of the scheme. Are they prepared over there to reduce their tariffs so as to admit a sufficient flow of imports? Are they prepared to accept the logic of their position as creditors, and import more goods than they export? There is a close parallel between the position of the United States to-day and our own position as a big creditor nation in the nineteenth century, but with a significant difference. We of necessity accepted the implication of our position because then, as now, we needed imports of food and raw materials. So we admitted imports and readily made loans. But America is to a large extent self-supporting. Does she *need* imports? And yet how otherwise can she obtain repayment of loans or payment of interest unless she will take payment in the only way in which it can be made—in imports? As to our own country, we have still to learn whether multilateral trade can be successfully combined with a regulated internal economy.

For the time being multilateral trade is a long way from being an accomplished fact. Consequently it is rather disturbing to notice from the trade returns[15] that we are not selling our goods across the Atlantic in anything like sufficient volume. While we have the remainder of the American and Canadian credits to draw against, our need for dollar exchange is not so vital. But when we reach the end of these resources we shall need to sell our exports over there in considerable quantity. We

TABLE 7—REGIONAL DISTRIBUTION OF EXPORTS

Country	3rd Qtr. 1946	2nd Qtr. 1946	Order of Importance	
			2nd Qtr. 1946	1938
	million £	million £		
1. British India	21·0	19·0	1	3
2. Union of South Africa..	19·0	16·4	2	1
3. Denmark	14·7	12·6	4	10
4. Australia	14·0	14·2	3	2
5. Eire	9·2	9·4	6	7
6. United States of America	8·7	8·9	7	6
7. Canada	8·3	7·2	9	4
8. Netherlands	8·2	7·3	8	12
9. New Zealand	7·3	6·0	12	9
10. France	6·9	10·5	5	11
11. Belgium	6·5	6·6	10	17
12. Germany	6·2	3·8	18	5

"Regional Distribution of Imports and Exports, 3rd Quarter of 1946". *Board of Trade Journal*, 10th November, 1946.

are obliged to look to the United States and Canada for a great many of the things we want, and it is to be hoped that we shall be able to find adequate markets there as time goes on. I will say no more on these points. I for my part will watch future developments with these considerations in mind.

Whatever comes of the American proposals for world trade, the fundamental position of our country will be the same. We shall still need food and raw materials and we shall still have to sell our manufactures abroad to pay for them. How can we best ensure our full share of the world's markets?

As a banker I should be stepping outside my province if I attempted to deal with the practical aspects of this question. It is a matter for those directly engaged in the export industries. I can only view the matter as it appears to an onlooker, and bring to your notice several points that seem to me to be beyond dispute.

First of all, it is clear that the nature of the demand for our exports has changed. The world no longer looks to us for the cheap goods, the coal, iron and cheap textiles which were the foundation of our prosperity in times past. It is the more specialised products that are now in demand, capital goods and also consumers' goods of the luxury and semi-luxury types. Consequently we must be prepared to adapt our export industries to this change in demand.

Second, as skill is more important than raw material content in the manufacture of such exports, our labour force, particularly as it is in any case inadequate for our needs, must be made much more efficient. In this it can be aided, of course, by research, by modernisation of plant and by reorganisation of methods. But the individual worker—and manager—must be personally more efficient. I must confess I am doubtful whether present conditions tend of themselves to produce any such increase in efficiency. Yet clearly there is little hope of our working out

our own salvation unless workers realise that a shortage of labour places a greater responsibility on them and is not simply a signal to make hay while the sun shines.

Third is the thorny problem of costs. We cannot, it seems to me, compete on their own ground with countries having a low standard of living. We must concentrate on those lines of production wherein we have an advantage of skill or opportunity, and leave to others the markets in many of the cheaper goods which we could formerly sell without difficulty.

Lastly, it is needless to say that our marketing technique must leave nothing to be desired. We must seek out the purchaser; he will not come to us. We must give him what he wants, not what we should like him to want.

Conclusion

On the whole my remarks have not been very encouraging. But I see no grounds for pessimism. The intensification of industrial development abroad has brought about a change in the nature of the demand for our products, but it does not involve a reduction in the volume of world trade as a whole. It has not done so in the past. Rather it leads to a rise in living standards generally and a greater and more diversified demand for "secondary" products. And is there any limit to the expansion of world trade on these lines? I see none while there remains such enormous scope for the improvement of the living conditions of a great part of the world's population.

But when all is said and done the solution of Britain's own particular problems lies now, as always, with the British people themselves. It is on their enterprise and initiative that everything depends. And I think they are realising more and more the true nature of the situation. I think they realise that their prosperity is not a thing divinely ordered for the exclusive benefit of the British race. Such ideas date from an age when we enjoyed exceptional advantages. We were once a great exporting nation; we are now a great importing nation. Our standard of living and our plans for social betterment depend on our success in foreign trade.

Is there any reason to doubt that the British public, who have so often in the past demonstrated their ability to rise to the occasion, will fail to do so now? I think not In the nineteenth century we chose the path of industrialisation and Free Trade. It was not always an easy path. But our trade made possible the opening up of the New World. In the twentieth century British commerce has a no less essential part to play in the spreading of prosperity to countless millions among the backward races of the world. If this role is creditably sustained, I think it will be accounted to Britain by posterity as the greatest achievement of all.

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DISCUSSION

Mr. A. F. ENSOR: May I ask one small question which has to do with our trade position to-day? I should like to know the effect on our trade position of German economy being so depressed compared with its condition before the war, and of the proposal to restrict its capacity for war output and therefore its capital industry. Is this a diminution of an economy which might be a good customer or of a competitor?

Sir CHARLES LIDBURY: When you come to consider Europe before the war you will see that the economy of all the smaller nations rested on the economy of Germany. If she is destroyed as a great economic unit, I believe we shall be destroying very largely our own market.

THE CHAIRMAN: Well, like Agag of old, I am going to walk delicately and make no comment on what has been said, lest the danger is not past and I am hewn to pieces! The facts have sunk in, however; one is that we must improve our methods and the other is that we must work harder.

I am sure you would wish me to thank Sir Charles Lidbury for a very interesting and enlightening lecture.

The vote of thanks was carried with acclamation, and the meeting then terminated.

SIR WILLIAM JACKSON POPE: HIS INFLUENCE ON SCIENTIFIC ORGANISATION

By Dr. L. H. LAMPITT, D.SC., F.R.I.C.,

President of the Society of Chemical Industry

Sir William Jackson Pope Memorial Lecture

Fifth Ordinary Meeting, Wednesday, December 4th, 1946

E. K. RIDEAL, M.A., D.SC., PH.D., F.R.S., *Fullerian Professor of Chemistry, Royal Institution, in the Chair*

THE CHAIRMAN: Memorial lectures may be either sad or happy events, depending upon one's knowledge and proximity to the man who is being honoured by such a lecture. I feel very honoured that the Royal Society of Arts have asked me to take the Chair at this second Memorial Lecture to my old teacher and colleague, Sir William Jackson Pope.

There are a great many aspects of the life of a man. A great man has many facets and each of those is probably distinct in its own particular field. Now, whether we look at the life of Pope as a collector of pestles and mortars, as a collector of old prints, as one of the great men of chemistry in linking up in asymmetric form non-carbon elements, whether we regard him as an expert in red wines or whether as the founder of one of the most important technical processes for re-forming cellulose into artificial fibres, whether from the point of view of the University of Cambridge we regard him as the founder of the large, complete chemical organisation which exists there to-day—and it was his foresight which ensured its being highly endowed—all these are aspects on any one of which a memorial lecture could be given. From the international point of view—and many of us are now increasingly perturbed by, and attentive to, the international situation—we in this country, with respect to chemistry at any rate, have never had a greater man than Pope. There are many of his international aspects which probably occur to all of you here. It may be that you will think of him in connection with the International Union of Chemistry, or in the much smaller, and to many, the more interesting field of the Solvay Conference, of which he was the leader and guide.

So it is time that the second Memorial Lecture should be devoted to some of the international effects which Pope had on the science of chemistry. To give this lecture

your Committee have made a very happy choice in Dr. Lampitt, because he is one of those who have been connected with the international development of chemistry ever since the idea of internationalism in chemistry was put forward. Dr. Lampitt has also the advantage of having been treasurer to the International Union of Chemistry in recent years.

I think that Dr. Lampitt needs no introduction. Himself President of the Society of Chemical Industry, he has an international reputation not only in that he is one of the directors of one of the largest, if not the largest, firm in the world dealing with what we in England now regard as a most important commodity, but he has himself seen that that firm is in the vanguard in the introduction of scientific applications to its particular industry. Sir William, as we remember him, was always anxious to see the application of scientific methods to industry. I will now call upon Dr. Lampitt to deliver his lecture.

Dr. Lampitt then delivered the following lecture :

It is but rarely that an unbiased biography of a man is written. If it be written during the lifetime of the person concerned, a frank discussion of the facts cannot be undertaken. If it be written immediately after the death of the person, a calm survey is difficult of achievement, and if written after some long period, the personal impressions of those who knew, talked with, and worked with the person are either not available or are not fresh in the memory. As Lytton Strachey has said: "To preserve a becoming brevity—that surely is the first duty of the biographer. The second, no less surely, is to maintain his own freedom of spirit. It is not his business to be complimentary; it is his business to lay bare the facts of the case as he understands them". I am not the biographer of Sir William Jackson Pope, but it may be that should my words be published they may be used by someone who will eventually write the biography of this great man. Therefore, I will try to obey the spirit of Mr. Strachey's remarks.

A hotel lounge very late at night—actually early in the morning; a group of some dozen people varying in ages from twenty-five to fifty-five, some earnest, some flippant, but all being dominated by a somewhat lazy figure sprawling in the easiest chair available. The discussion, chemical politics; the time, shortly after World War I. "Chemists must unite in order to force upon the reluctant world the power of their discoveries". Such is one of my first memories of Pope. Few of that group now remain; but here is the impression—soon to be wiped from the slate of time.

Others have spoken of aspects of Pope's work, pens have recorded his academic prowess, his vast linguistic abilities—they tell but part of the tale. May I speak on another aspect, may I try to present another facet of this truly remarkable man? I wish to speak of his influence on the organised body of chemists.

What background should one have to exert such influence? The two major societies, apart from the Royal Institute of Chemistry, are the Chemical Society and the Society of Chemical Industry, and no one who has not served on the Councils of these two bodies is competent to speak for chemists. Chemistry is indivisible—it is not Pure and/or Applied—it is Chemistry. The bias of the Chemical Society is towards the "Pure", that of the Society of Chemical Industry towards the "Applied", and therefore it is only when one has absorbed the spirit of both these bodies, has felt the atmosphere of the respective Councils, that one has a clear perception of the difficulties and an appreciation of the possibilities of

collaboration. Pope served as a member of the Council of the Chemical Society for a period covering some twenty-three years, and of the Council of the Society of Chemical Industry for some ten years. He was President of both Societies. He therefore fulfilled the conditions I have mentioned, having served a good apprenticeship before embarking on the schemes which led to such close collaboration between these and other chemical bodies. It is perhaps of some significance that the effects of his organising ability are to be noted during his terms of office of these two Societies; for having been instrumental, during his Presidency of the Chemical Society (1917–19), in overhauling the bye-laws (and during this period women became eligible for fellowship for the first time) he proceeded during the next two years, when President of the Society of Chemical Industry, to do the same thing for that body.

It was during his period of office as President of the Chemical Society that he first spoke of his plans for collaboration between the various chemical bodies. Thus, in his Presidential address to the Chemical Society in 1918, he suggested that:

> "The Chemical Society, the Society of Chemical Industry, the Institute of Chemistry, the Association of British Chemical Manufacturers and any other interested bodies, should set up a joint committee or council to consider national questions in which any of the varied interests of chemistry are concerned, and to make such representation to our administrators as would voice the appropriate view of the joint body."

It is not necessary to recapitulate Pope's arguments, historically interesting though they may be, but he was a firm believer that collaboration between scientists and the Government would have been of inestimable worth during the 1914–18 war. Moreover, his realistic attitude to life convinced him that only by collaboration could the voice of English chemistry be heard in international affairs.

And here I must digress for a moment from consideration of home affairs to speak of his effect on Anglo-French chemical relationships, which were, in fact, the precursors of the International Union.

As the President, Monsieur Bienaimé, of the *Société de Chimie Industrielle* has said only this year, this French Society had as its prototype the Society of Chemical Industry, "the elder sister" as he called it. It was largely through the contact between Monsieur Paul Kestner, Pope, H. E. Armstrong and Stephen Miall that the French Society came into existence; close ties have bound the two Societies together ever since. It was Pope who headed the British delegation which attended the first Congress organised by the *Société de Chimie Industrielle*, and, at the Annual Banquet he spoke of the potentialities for good that Anglo-French understanding would have on the general international situation. It is of great interest to all that the first post-war Congress of the *Société* this year should have been attended by a greater number of foreign representatives than ever before. About this time was founded the Catalysts Club. Here again, that far-sighted trio, Pope, Armstrong and Miall, were the originators, and they gathered round them a group of important chemists (the membership to begin with was strictly limited) with one object and one object only, to provide an organised body to act as host to any visiting foreign scientists. The first to be so fêted was Paul Kestner. The conversation at the original meetings of the Catalysts was sparkling, and many were the international

giants entertained. Did time permit, much more could be said of the Catalysts and the important effect they had on many national and international movements.

To revert to national collaboration. Pope favoured federation and was fundamentally opposed to amalgamation. In fact, when in later years the idea of a Royal Chemical Society was mooted to embrace all or any of the societies dealing with chemistry, he did not actively support it. Hence, collaboration took the form of a Federal Council of Pure and Applied Chemistry. The Federal Council was constituted of representatives of the following: the Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Society of Public Analysts, the Faraday Society, the Biochemical Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institute of Gas Engineers, the Society of Leather Trade Chemists, the Mineralogical Society, the Institute of Metals, the Royal Agricultural Society.

It will be seen that practically every aspect of chemistry and its application were covered, and although the Royal Institute of Chemistry was not a member, it was associated with the movement, and sent a representative to the meetings.

Those of us who have been concerned with practically every movement to bring scientists nearer together during the last twenty-five years have every reason to be disillusioned, to be depressed, to lose our enthusiasm. I have spoken in some detail of this in another context. There are many reasons why successful collaboration has not been achieved. Fortunately we have not that cleavage between the academic and the applied scientist evident in other countries, but neither have we the close union which pertained in Germany before the Nazi régime, a régime which forced collaboration and created great underground rifts. But Pope was a realist. He *knew*, and he affirmed it repeatedly, that in 1918, the Royal Society, with its close official connection with the Government, was incapable of representing applied science, was incapable of reflecting the impact of modern scientific thought on industry and could not interpret the influence which science, and in particular chemistry, had on the economy of the nation. As P. F. Frankland, another great figure so lately passed from amongst us, had realised in 1905, the impacts of science and industry were so important to the well-being of the nation, that chemical science and industry must be prepared to speak as one voice—their interests were essentially the same. There were, naturally, many in the academic world antipathetic, nay, antagonistic, to the formation of the Federal Council, and Pope, who had no patience with those who had no vision or whose interest was bounded metaphorically by the walls of a test tube, spoke scathingly of the academic mind on many occasions, at early meetings of the Federal Council. I have said he was a realist, perhaps in his later years unfortunately disabused, and on one of the last occasions that I discussed with him the possibility of a Chemical House, his advice was: "Do not put any trust in princes"—it was at a time just before the last war, when the first rumours of a science centre sponsored by the Government were made through the Royal Society. As the reports of the Chemical Council have shown, no progress has been made in respect of this great conception of Pope's.

Pope delivered many addresses on the functions of the Federal Council, par-

ticularly in the years immediately after its formation. According to him, its chief aims, other than the one mentioned, were:

(1) To achieve as great a measure of co-operation as possible between teh various chemical societies in Great Britain.
(2) To improve existing British chemical publications.
(3) To represent British chemists *vis-a-vis* the Government and the Nation.
(4) To represent British chemists *vis-a-vis* the chemists of other countries.

In many respects the Federal Council did not achieve anything like the amount of success which its originators had assumed would follow from its foundation. What did it achieve? I will deal with the international aspect later, but what of its home effect? It certainly brought chemists representative of all aspects round a common table, and had Pope's initial driving force been maintained, it is certain that the original goodwill could have been developed. I for one deplored its passing, and still deplore that there is no common meeting-ground for the bodies which originally agreed to collaborate, a number which to-day could be considerably increased.

Pope had many almost revolutionary ideas regarding publications and the dissemination of scientific knowledge, but the only record I can find of Pope's direct influence on the publishing of scientific journals is that at his initiative the Federal Council was intimately concerned with the change which took place in 1922-23, whereby the fortnightly *Review* of the Society of Chemical Industry was changed into the weekly *Chemistry and Industry*, the new journal being designated as the official organ of the Federal Council.

Lately the Association of Scientific Workers has concerned itself with the dissemination of scientific knowledge, and Professor Bernal (I believe it was) has propounded a scheme which entailed the same format for all scientific journals and their sectionalisation, so that any individual scientist could obtain just those sections he required, and bind them together if desired. During my period as Chairman of the Chemical Council, a similar scheme was propounded, but no measure of agreement between the various publishing societies was reached. But Pope was even before me, for he told me that previous to my membership of the Federal Council, he had suggested a similar, but less comprehensive scheme.

Whilst on the subject of dissemination of scientific knowledge, a reference should be made to the somewhat curious enthusiasm lately displayed in official circles for the micro-film, as though it were a new invention. Under the ægis of the *Maison de la Chimie* in Paris a plan was worked out many years ago for a distributing service for micro-films, and the matter was actually referred to the Federal Council. The decision was that micro-films might be regarded as an alternative to the normal method of publication, but that they could not replace the printed journal. One feels that had Pope's idea of the Federal Council as adviser to the Government developed, the apparently ill-considered publicity given to the micro-film during the last few months would have been avoided.

In many of his earlier talks, Pope had deplored the unwillingness of politicians, of lawyers, and of Government Departmental Committees, to accept scientific advice in political, economic, and legal matters. He attributed this to the narrow classical education then given to potential administrators, and the consequent lack

of any appreciation of the value of scientific knowledge and advice. In his Presidential address to the Chemical Society in 1919, Pope discussed the causes which had led to a change in this attitude during the war of 1914–18, and gave as one of the reasons the contributions made by many chemists to the war effort. In this respect, Pope himself did a considerable amount of important war work, the details of which have already been discussed by Professor Gibson,* and for which he was awarded the K.B.E. Under Pope's guidance the Federal Council took an active part in presenting the opinions of British chemists to the various Ministries and Governmental departments on a wide variety of subjects. Thus, he led a deputation from the Federal Council to the Board of Trade in 1924 in connection with the British Dyestuffs Industry. Representations were made in connection with the Safeguarding of Industries Act, the Patents and Designs Act, etc. The status of scientists in the Civil Service was another subject on which representations were made to the Government.

In all of these activities, Pope's enthusiasm and force of character were of inestimable value. It has been said that the last instanced deputation should have been the duty of the Institute of Chemistry as it then was, but Pope maintained that the Institute, composed of professional chemists, lacked the breadth of view of the Federal Council.

Another fact not generally recognised is that the Federal Council, under Pope's advice, took part in the preliminary discussions and initially strongly supported the establishment of the British Standards Institution.

The Federal Council was finally dissolved in 1935, and during the whole period from 1918 to 1935 Pope was President. Herein perhaps lay the cause of some of its failures. It is not an exaggeration to say that jealousy of Pope gradually developed, and in the later years, some of those who had been his greatest supporters fell away, and others gradually realised that although he still had the enthusiasm and the foresight, the Federal Council had to an extent become to him a routine. He founded the Federal Council, and he destroyed it.

Difficulties in respect of the Federal Council had indeed become acute in 1932, and Pope's policy was severely criticised. A committee was appointed to consider anew the problems of co-ordination in British chemistry. This committee, of which Pope was a member, finally recommended the division of the work of the Federal Council into two parts. Under this new arrangement the Federal Council was dissolved; its work in home affairs was taken over by the Chemical Council, whilst its work in the international field was carried on by the British National Committee for Chemistry of the Royal Society.

Pope was a member of the Provisional Council that was formed to draw up the constitution of the Chemical Council, but was never very enthusiastic about it. He regarded it, and did not hesitate to say so, as far too limited in interest. Although initially the idea was to bring all the bodies represented on the Federal Council on to the Chemical Council, difficulties arose. Some of us felt that it was better to start with a few collaborating bodies than not to start at all, and that on the basis of the Chemical Society, Royal Institute of Chemistry, and Society of Chemical

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Industry, could be built a new federation. Unfortunately Pope was not elected as a representative on the Council finally constituted in 1935. Perhaps it was a good thing, for he would certainly have had no patience with the long drawn-out negotiations before the Chemical Council ever got to work.

After the dissolution of the Federal Council in 1935, Pope remained a member of the British National Committee for Chemistry until his death in 1939.

I feel that before passing to a short review of Pope's influence on international chemical organisation, I should stress his broad outlook on the inter-dependence between chemistry and industry. It must be remembered that in Pope's early days the chemist was in a far less important position in industry than he is to-day. In the brewing industry the importance of chemistry had been recognised and the larger companies not only had control chemists, but also important research laboratories. The fundamental work of such men as O'Sullivan, Horace and Adrian Brown and others had given an explanation of the complicated enzyme changes taking place in the conversion of the starch of the barley to the alcohol of the beer. The problem of flour milling, particularly the scientific development of strains of wheat, were being considered, and initial work on the correlation of the chemical composition of flour with its baking qualities were being studied. The importance of chemistry in metallurgy was recognised, and of course our dyeing and heavy chemical industries were dependent on the work of the scientist. Even before 1914, Pope was already urging a greater measure of participation by science in industry, for he firmly believed that the modernisation of industry and of agriculture—both essential to further progress—could only be brought about by the employment of scientific staffs, and by attention to investigation and research. A change of this character could not, however, be introduced unless a supply of properly-trained young chemists was available. It is here that Pope's interest in industry links up with his desire for improvement in technical education. In the Trueman Wood Lecture given by Pope to the Royal Society of Arts in 1924, on "The Outlook in Chemistry," Pope stresses the value to industry of co-operative work by teams of chemists on a given industrial problem: a point of view which has since been amply vindicated. Pope urged the potential industrial value of the tropical products available within the Empire, and was convinced that much greater use could be made thereof: again a suggestion which has recently come to fruition in the formation of the Colonial Research Committee and the Colonial Products Research Council.

It is hardly necessary to say that the position of affairs to-day amply justifies the foresight of Pope, even though in 1914 his remarks were often regarded as those of a visionary by industrialists, and by the academically minded, as indicating the possible prostitution of chemistry.

As I have remarked before, Pope believed in collaboration—it is not recorded as far as I am aware, but I have heard him talk on the possibility of a great joint scheme between the members of the Chemical Society and those of the Society of Chemical Industry—collaboration almost amounting to coalescence. This was some twenty years or so ago—when joint action by the two bodies was an almost undreamt-of possibility, when competition and jealousy and not mutual help, were the order of the day. To-day these two bodies, the two principal chemical publishing bodies of the country, whilst maintaining their own characteristics, their own aims

and objects, walk in step and to a certain extent have amalgamated their administration organisation in the Conjoint Chemical Office of the Chemical Council. It is such men as Pope who, looking ahead, start the ponderous machinery of collaboration in motion.

Pope recognised another potential source of power through collaboration—the City Companies. He considered that the City Companies (wealthy as they were then, and perhaps are to-day, although temporarily embarrassed) were a potentially powerful factor if they could be induced to interest themselves in science. It is true that many of these have done yeoman service in the field of education by founding schools and scholarships, but their direct interest in science was, and still is, not in proportion to their importance. The Salters certainly maintain a direct connection with science, and Sir Robert Robertson—a stalwart supporterof Pope on international matters—directs their chemical activities, but I think that Pope forgot that except for the Apothecaries (still essentially restricted to medically trained men) the great majority of the members of any city guild are not concerned with the trade they are supposed to represent. Pope had early connections with the Goldsmiths' Company, and later occupied a position of considerable influence therein, becoming "Prime Warden" (1928–29). He succeeded in persuading the company to devote considerable funds to technical education, a subject in which, as I have said, he was interested from his early days. However, he did not succeed in marshalling the companies as a whole and I believe that after preliminary interviews his project was not pursued.

Another important collaborative movement, ably supported by Pope, was the formation of the Bureau of Chemical Abstracts, a venture sponsored by the Chemical Society and the Society of Chemical Industry. Mr. T. F. Dunn has lately dealt with this in his Jubilee Memorial Lecture to the Society of Chemical Industry.

Finally I come to that aspect of Pope's influence on scientific organisations which was perhaps the most important, certainly the most spectacular. In what characteristics lay his great influence in foreign countries? He was a chemist of great ability and was therefore *persona grata* with the leaders of scientific thought in all countries. He was a great linguist and therefore could understand and be understood by men of many nationalities. Neither of these would have carried him very far. I have known other Englishmen almost as well equipped from these angles who have not achieved anything like Pope's success in the international field. These qualifications were simply the foundation, well and truly laid. In my opinion, having watched him in council, having been with him at the more intimate small meetings where policy is decided, where bridges are built and ways round found, his greatness depended on his tolerance. Many of those who knew him here will be surprised at this statement, many will say that Pope was certainly not tolerant, and yet when dealing with other nationals he was able to see their point of view clearly, and it was this intimate knowledge of the character of the people, the nation, its aspirations, its inferiority complexes, which gave him pre-eminence.

In collaboration with a number of leading foreign chemists, Pope took part in the creation of the *Union Internationale de Chimie Pure et Appliquée* in 1919. The Federal Council became affiliated to the *Union Internationale* as its British Section, and Pope as President of the Federal Council was elected a founder Vice-President of the Union. Later (1922–24) he was President of the *Union Internationale*. Pope

and the Federal Council devoted much time and trouble to putting the newly-created Union on a sound basis.

It must be remembered that the official domicile of the Union was in Paris, and Pope, H. E. Armstrong, Miall and Emile Mond collaborated most closely with the indefatigable General Secretary, Jean Gerard; but it is not easy for the Anglo-American mind and the French mind to work together in true union.

It must not be forgotten that the "set-up", to use an American phrase, of a Continental organisation is very different from that of an English organisation. My experience is that on paper a definite scheme of work is proposed, but the more philosophic attitude of the Latin race is to be content and to wait for results. Thus many Commissions, or Sub-Committees as we should call them, dealing with nomenclature, etc., were elected; and at the annual meetings the talk became interminable on the interpretation of the meaning to be attributed to the reports of these bodies.

In fact, the methods of approach of the Anglo-Saxon and of the Latin races are different, and by 1928, English and American chemists were perturbed at the general condition of affairs of the Union. In that year, Pope, on behalf of the British delegation, submitted a number of criticisms and suggestions designed to reorganise and improve the work of the Union. It was suggested that many of the Commissions set up by the Union had functioned either badly or not at all, and that most of them should be dissolved, with instructions to those which remained in being, to proceed with their work much more rapidly than hitherto. The character of the meetings was also criticised, it being stressed that they should be concerned more with the discussion of selected scientific topics than with hearing reports of its committees. These suggestions caused a considerable stir, and were very largely adopted. It was Pope's personality which made it possible for this change to be effected without rancour.

It has been said that the Union became too politically minded. Having had considerable experience of this and other international bodies, it is my opinion that this political bias is inevitable. I am not referring to the abnormal state of affairs persisting at the Rome Congress, where Germany and Italy had their thousands of delegates to the tens of other countries. That had no political significance, for the work of the Union has no reference to the Congresses which it stimulates, for the Council and Bureau of the Union control its activities and the membership of these bodies is strictly limited; but voting at Council meetings must and I think always will have a political bias. For example, the admission of Germany to the Union in 1924 was decided only after a strenuous fight, and in the final voting the motion was carried by the Anglo-Saxon, the Scandinavian and the Dutch votes against those of the Latin countries. This was an outstanding example, but the number of such incidents would have been far greater had it not been for the wisdom of Pope and his great influence, both in the limelight and behind the scenes.

I feel strongly that Pope's work in this important international field has not been sufficiently recognised, although it is true that at the last meeting of the Federal Council, in proposing a vote of thanks to Pope, H. E. Armstrong said that Pope had rendered valuable services in representing British Chemistry in international

scientific affairs; and that a resolution of the Council of the Chemical Society adopted after his death, refers to "his pioneer labours in the international organisation of our science".

Nevertheless, these are but small tokens of appreciation for his incessant labours in this field. Although Professor Gibson last year spoke at some length of the Solvay Congresses, this would not be a complete record of the collaboration work of Pope were I to omit all reference to them.

These congresses were constituted by the Belgian chemist, Solvay, after the World War I, and consisted of periodical discussions on some particular chemical topic by some twenty to thirty leading chemists gathered from a number of countries. Article 6 of the Statutes mentions that Pope was to be President of the scientific committee of these Congresses until 1930, and thereafter to remain an extraordinary member of this committee. Actually Pope remained President from 1922 to 1937, and took an active part in the discussions that were held in 1922, 1925, 1928, 1931 and 1934. Here again, his linguistic abilities served him in good stead. He was able to translate from the Chair the contributions that were made in French into English, and from English into French, thereby contributing materially to the progress of the discussions. According to his successor, Pope's Presidency of the Congresses had contributed very largely to their success. For his work as President, he was made in 1937, *Grand Officier de l'Ordre de Leopold.*

I have stated that in my opinion Pope's success in bringing together people of all nations was due to his "tolerance". But he had another attribute which stood him in very good stead, and one which I have not seen commented upon. This was his appreciation of food and wine. In my opinion he had not the palate of E. F. Armstrong for ports and burgundies, nor would his general knowledge of wines compare with that of another great international figure, Professor Donnan, but in respect of German wines he was no mean connoisseur. He was not an outstanding gourmet—it is in fact curious how few English chemists I have met who could be called gourmets—but he had a definite sense of a well-balanced meal, and being a very much travelled man, he knew the speciality of any district in which he found himself, and could speak with knowledge of the methods of preparation for the table of such specialities. It is not necessary for me to stress that knowledge of food and wine was not an unimportant factor in his success at the many private parties to which he was invited. Incidentally, he had one of the finest private collections of books on the culinary arts in this country.

I consider it an essential, for a man to be an international figure, that he should have lived, studied and worked outside the insular restrictions of this country. Previous to 1914, there were many such. To-day the number of active scientists who satisfy these requirements are only too few. Appreciation of the continental mind, familiarity with the mode of life, are but two of the essentials which only come from intimate contact.

Pope had these and many other attributes, but he also had a reticence and awkwardness which prevented full discussion of the reasons which caused him to decide on a course of action. Councils and Committees therefore became antagonistic to him; and yet, in private, I found him most appreciative of sincere and open

criticism, and willing to listen to the point of view contrary to his own. He had no time for people who spoke for the sake of speaking.

And so end my comments on this great English figure—a dictator who disliked dictatorship—a visionary with both feet on the ground—a man with a "single eye", but tolerant towards the viewpoint of others—a diplomat with no time for politics—and a good friend.

THE CHAIRMAN: I am sure that we have all appreciated to a remarkable extent the very brilliant address to which we have just listened. There are certain aspects in a man's life that any biographer is expected to cope with—questions of fact, questions of obvious policy and so on—but it is very rare that the biographer knows so well the man about whom he is talking, and has such a shrewd judgment of character that those psychological factors which go to make up our minds can be presented to an audience; and this our lecturer tonight has done. Many of us who have known Sir William for many years have suspected this or that characteristic, but I do not think that many of us have been able to assess the relative importance of those factors in Pope's career as well as our lecturer. One can see that Pope's life, from his point of view, must have been a disappointment. Great ideas such as his go to a certain stage of development, and then the rugged individualism of our country breaks them down again; and we cannot help feeling that that disappointment was accentuated by the fact that Pope was a shy man in public.

He suffered in other ways which our lecturer mentioned briefly. It was the custom of the International Union to travel over the country and their hosts in the respective countries said "What is the best thing to give our guests for a meal?" In Yugoslavia it was caviare, in Spain octopus, and as these meetings sometimes lasted over a week one can imagine what were the gastronomic sufferings of a week of octopus!

I do not think I can express our thanks to any greater extent than by saying that we have all thoroughly enjoyed and appreciated the wonderful lecture which has been given to us to-night.

Professor GIBSON: It is now my privilege to ask you to thank Professor Rideal for coming to preside over the second Pope Memorial Lecture, a lecture which I personally have thoroughly enjoyed and deeply appreciated. Our Chairman has recently left the calm by-ways of Cambridge to come and teach us in London. I hope he is going to succeed, for we need his teaching and we need him. It is a very great honour for us to have Professor Rideal taking the Chair at a lecture under the auspices of the Royal Society of Arts, particularly in view of his very close relationship with the subject of the lecture. I ask you to thank him most sincerely.

The vote of thanks was carried with acclamation and the meeting then terminated.

GENERAL NOTES

THE YOUNG VIC.—This theatre for young people is an enterprise sponsored by the Joint Council of the National Theatre and the Old Vic, in association with the Arts Council of Great Britain, and forms part of an organisation to be known as the Old Vic Theatre Centre. Its purpose is to present to young audiences theatrical performances specially selected and produced for them. The Ministry of Education is known to approve in principle the aims of the movement, which are very much in line with modern methods of creative and visual education.

Although based on London, The Young Vic will operate in all parts of the British Isles. It will play in theatres and professionally-equipped halls in order to give the audience an authentic theatrical atmosphere. A Public Relations representative will tour

the towns which are to be visited, to enlist the help of local education authorities, principals of private schools, organisers of Youth Movements and others. Later it is hoped that The Young Vic will be able to encourage a general interest in the theatre in all towns that it visits, by means of exhibitions of designs and models, discussions, talks and demonstrations.

The first production of the Young Vic, "The King Stag", an adaptation of an eighteenth-century "tragi-comical fairy tale" by Carlo Gozzi, has just completed a five weeks' season at the Lyric Theatre, Hammersmith, and is now to tour the provinces for four to five months. Other plays on which The Young Vic is working are adaptations of "The Birds" and "The Peace" by Aristophanes; a translation of Tolstoi's "The Golden Key" and special versions of "A Midsummer Night's Dream" and "The Tempest".

The Young Vic deserves support for having set out to fill a gap in our educational life with such vision and understanding of the problem. There seems little doubt that if it is given this support in its early stages it will succeed before very long in establishing itself as securely in the affections of the rising generation of playgoers as its forerunner, the Old Vic, has done with the more adult theatre public.

Fellows who wish to learn more about the movement should write to the Secretary, The Young Vic, Waterloo Road, S.E.1.

J. S. R.

THE BUREAU OF CURRENT AFFAIRS.—Many, who served in the Forces in the past war, will remember the work of the Army Bureau of Current Affairs, which worked to widen the horizon and improve the capacity for citizenship of men and women in the Services, both by providing information and by promoting the discussion and original thought without which information is sterile. As many of the men and women left the Forces, so did the A.B.C.A. shed its military attachment, and was established in the Spring of 1946 as the Bureau of Current Affairs, to supply on a nation-wide basis the same services for promoting a wider knowledge and discussion of current affairs. Incidentally, it continues to do the work of the parent body in the Forces, as part of its enlarged programme.

The Bureau of Current Affairs is above all a service of support for the discussion group movement. It does not attempt to establish discussion groups, but to provide the background of information with which discussion will come naturally, and more specific material for debates on particular subjects, so "provisioning" discussion groups wherever they may be founded. Two fortnightly publications devoted to these ends are its pamphlet "Current Affairs", a discussion brief of about twenty pages on some subject of topical interest, written mainly by some accepted authority, and "Map Review" a poster-map with pictorial presentations of the fortnight's news, and a particular treatment of one subject. Amongst other services in operation or projected, the Bureau runs courses for training discussion group leaders, and is building up a reference library.

The Bureau is of course non-partisan, but it is also independent of any Government department. It is sponsored by the Carnegie United Kingdom Trust, and will eventually be controlled by a representative governing body of its own.

OBITUARY

MACDONALD GILL.—We regret to announce the death, on Tuesday, January 14th, of Mr. MacDonald Gill, F.R.I.B.A., F.R.G.S., N.R.D., architect and artist. Mr. Gill was most widely known for his decorative maps, which appeared as posters, advertisements, and mural decorations.

Born in Brighton in 1884, the son of the Rev. A. T. Gill, he was educated at the Royal Naval Academy, Bognor, and the Central School of Arts and Crafts, London.

In 1901 he was articled as an architect, and served as assistant to Sir Charles Nicholson and Mr. H. C. Corlette from 1903 till 1908. Examples of his architectural work are to be seen in St. Paul's and Chichester Cathedrals, in St. Paul's School, London, in several Sussex churches and in Oxford colleges. His cartography included designs for the Empire Marketing Board, the Underground Railway, the G.P.O. and the Ministry of Information. Many Fellows of the Society will remember the large map which he executed as a guide to the Society's Exhibition of British Art in Industry at Burlington House in 1935. His work in mural decoration can be seen in Lincoln Cathedral, the Scott Polar Institute, the Guildhall, Cambridge, and the Houses of Parliament, to mention a few examples. He also served for some years as designer to the Imperial War Graves Commission. He was a Fellow of the Society for eight years.

NOTES ON BOOKS

BUTTERFLIES AND MOTHS IN BRITAIN. By Vere Temple. With 10 lithographic plates in colour and 57 drawings in the text by the Author, together with 95 photographic reproductions. B. T. Batsford, Ltd. 1946. 12*s*. 6*d*.

" In this book I have described butterflies and moths that I know, and I have written of the countryside that is their setting. But since our delight in the contemplation of Nature is increased by Knowledge, I have added a spice of information to my descriptions. Here my debt to others is great," in these words Miss Temple prefaces her book.

This is divided into three parts, the first " Butterflies," the second " Moths " and the third " Notes on collection, setting and storing butterflies and moths." After an introductory chapter in which is given a brief description of what butterflies and moths are, there are nine short chapters in Part 1 entitled " Spring," " Migrants and others," " The Forest," " The Fens," " The Downs," " Hedgerow and Hillside," " The Woodlands," " Grey Days : Some Notes on the Courtship of Butterflies " and " Autumn." The reason for these chapter headings is that the author is taking the reader on an imaginary tour in a motor-caravan round Britain to localities typical of certain butterflies. Thus Miss Temple starts during April in Kent and deals with the butterflies that hibernate and are the first to be seen in spring. A leisurely journey towards the New Forest allows time to mention the Whites and various butterflies that migrate. In the Forest the reader gets glimpses of the Fritillaries. After doubling back to the Fens in order to show the reader the Swallowtail, the caravan reaches Salisbury Plain where the Blues are studied. The hedgerow and hillside in Dorset provide the opportunity of mentioning the Browns, Ringlets and Skippers. Here the thin veil of the caravan tour breaks down. The Purple Emperor, White Admiral, Large Tortoiseshell and White-letter Hairstreak are associated with woodlands ; the courtship of butterflies with grey days ; and the Red Admiral and Comma with the autumn.

All pretence of a journey is dropped in Part 2 and after a preliminary chapter on moths generally, Miss Temple deals with the various groups of Moths in a further six chapters :—Hawk-moths ; the Prominents and Tussocks ; the Noctuids ; the Emperor, Eggars, Tigers and Footmen ; the Geometers ; and, finally, Primitive Moths and Tree-boring Caterpillars.

Part 3 consists of a single chapter on collecting, setting and storing. The book is completed by a short index.

It is somewhat difficult to judge clearly for whom such a volume is intended. The language verges sometimes on the " sloppy " which, besides annoying some otherwise would-be readers intensely, leads to inaccuracies and unjustifiable ideas ; e.g., p. 8, " though the six front ones " (caterpillars' legs) " remain " (in the chrysalis) ; p. 31, " thoughtful mother " ; p. 38, " the persevering mite " when writing of a small caterpillar ; and p. 63, " I can only imagine that the caterpillars rely for safety on their size and on the disconcerting effect that their expressionless green faces would have on an imaginative bird " when describing the appearance of the Privet Hawk caterpillar's

colouring; etc., etc. And is the caravan journey really necessary? It may be to some readers. But if one is not unduly perturbed by such writing there is a great deal of most interesting information contained in the book.

The coloured plates are most attractive, but here again, are lithographic plates the ideal medium for coloured illustrations of butterflies and moths? Personally the reviewer prefers the method of colour reproduction employed in South's Moths of the British Isles. In the near future, when the correct exposures are made and the technique has been perfected, direct colour photography may prove to be the best.

The photographic reproductions are excellent, particularly those of the eggs of butterflies and moths. Many of them are reminiscent of what one used to see in the days when moths were being reared. For this reason alone the book will have a greater appeal to those who collect caterpillars and search their hedgerows than many books whose main purpose seems to enable the butterflies and moths themselves to be identified.

The numerous drawings in the text add that attractive little to the book which gives the book its own individuality. So many collectors have seen the poses which the author has illustrated and yet so few are gifted sufficiently to enable them to make a lasting likeness. These will be indebted to Miss Temple for having done this for them.

The index while probably adequate does not strike one as having been made by the author. There are so many points of interest in the book not mentioned in the index and which can only be found by diligent reading and then by memory.

The book, while not the best for use as a means of identifying captures, is certainly most attractive and well worth a position on collectors' bookshelves as a source of many enjoyable moments. It should also serve as a means opening the eyes of many who find the country so dull and moths especially so drab.

Miss Temple is to be thanked for putting her experience on record and using her artistic gifts to such good purpose. The publishers are to be congratulated on adding yet another volume to their *British Nature Library*.

H. F. B.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, FEBRUARY 3..Electrical Engineers, Institution of, at the James Watt Memorial Institute, **Birmingham.** 6 p.m. R. Grierson and Forbes Jackson, "**Engineering Principles applied to the Design of Domestic Water-Heating Installations of the Solid-Fuel Electric Type.**"

At the Liverpool Royal Institution, Colwuitt Street. 6 p.m. H. A. Thomas, "**Industrial Applications of Electronic Technique.**"

At King's College, **Newcastle-on-Tyne.** 6.15 p.m. D. I. Lawson, A. V. Lord and S. R. Kharbanda, "**A Method of Transmitting Sound in the Vision Carrier of a Television System.**"

Farmers' Club, at the Royal Empire Society, W.C.2. 2.30 p.m. Col. The Rt. Hon. Walter Elliot, "**An Agriculturist's View of Economics.**"

Geographical Society, Royal, S.W.7. 8 p.m. Tom Manning, "**Surveying the Canadian North.**"

Mechanical Engineers, Institution of, at the Neville Hall, **Newcastle-upon-Tyne.** 6 p.m. S. J. Wright. "**Mechanical Engineering and Agriculture.**"

TUESDAY, FEBRUARY 4..Chemical Engineers, Society of, at the Institution of Structural Engineers, S.W.1. Conference on "**Particle Size Analysis.**" 10.30 a.m.—12.30 p.m. "**Methods of Measurement.**" 2 p.m.—5 p.m. "**Industrial Applications.**"

Electrical Engineers, Institution of, at the Engineers' Club, Albert Square, **Manchester.** 6 p.m. W. Fordham Cooper, "**Electrical Control of Dangerous Machinery and Processes.**"

Hull Chemical and Engineering Society, at the Church Institute, **Hull.** 7.30 p.m. W. C. Gilpin, "**Magnesia from Sea Water.**"

Kinematograph Society, British, at the Neville Hall, **Newcastle-on-Tyne, 1.** Leslie Knopp, "**Auditorium Requirements in Sound-Film Presentation—Acoustics.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester, 3.** 6.30 p.m. D. C. McKinley, "**Royal Air Force North Polar Investigation Flights.**"

WEDNESDAY, FEBRUARY 5..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5 p.m. C. Domb and M. H. L. Pryce, "**Calculation of Field Strengths over a Spherical Earth.**"

At the Cleveland Scientific and Technical Institute. 6 p.m. H. A. Thomas, "**Industrial Applications of Electronic Technique.**"

Public Analysts, Society of, at the Chemical Society, W.1. 6 p.m. (1) Mrs. Erica Glynn, "**Reductometric Determination of the Sulphoxide and Amine Oxide Groups.**" (2) W. P. Thistlethwaite, "**Determination of the Composition and Constitution of Ammonium Phosphomolybdate and the Conditions affecting its Precipitation.**"

THURSDAY, FEBRUARY 6..Auctioneers' and Estate Agents' Institute, 29 Lincoln's Inn Fields, W.C.2. 6 p.m. Michael E. Rowe, "**The New Towns Act, 1946.**"

Chemical Society, at Burlington House, W.1. 7.30 p.m. Dr. A. E. Alexander, "**The Application of Surface Chemistry to Colloidal Problems.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5 p.m. J. Hacking and J. D. Peattie, "**The British Grid System in Wartime.**"

Mechanical Engineers, Institution of, in the Chemistry Lecture Theatre, **Leeds University.** Dr. H. J. Gough, "**Research and Development Applied to Bomb Disposal.**"

FRIDAY, FEBRUARY 7..Chemical Society, at University College, **Cardiff.** 6.45 p.m. Professor W. Wardlaw, "**Structural Inorganic Chemistry.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5 p.m. F. E. J. Ockenden and G. N. Harding, "**What the Electrical Industry has to learn from developments in Continental Practice.**"

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. Professor A. Porter, "**Basic Principles of Automatic Control Systems.**"

Royal Institution, W.1. 9 p.m. Professor James Gray, "**Vitalism : Old and New.**"

SATURDAY, FEBRUARY 8..Electrical Engineers, Institution of, at the South Parade Pier, **Southend.** 3 p.m. J. Hacking, "**The Generation and Wholesale Distribution of Electricity.**"

MONDAY, FEBRUARY 10..Electrical Engineers, Institution of, at the Neville Hall, **Newcastle-on-Tyne.** 6.15 p.m. G. E. Haefely, "**Growing Importance of Plastics in the Electrical Industry.**"

Geographical Society, Royal, S.W.7. 5.30 p.m. William Courtenay, "**Trans-Pacific Flight.**"

TUESDAY, FEBRUARY 11..Electrical Engineers, Institution of, at Queen's University, **Belfast.** 6.45 p.m. H. A. Thomas, "**Industrial Applications of Electronic Technique.**"

At the Electricity Department, **Leeds.** 6 p.m. R. A. Smith, "**A Survey of the Development of Radar.**"

At the Demonstration Theatre, City Gas Department, **Nottingham.** 6.30 p.m. W. Szwander, "**Power Supply for Generating Station Auxiliary Services.**"

Illuminating Engineering Society, at the Royal Society of Arts, W.C.2. 6 p.m. J. S. Smyth, "**The Brightness and Legibility at Night of Road Traffic Signs.**"

Kinematograph Society, British, at the Manchester Geographical Society. 10.30 a.m. J. D. Wright, "**Uses, Care and Maintenance of Storage Batteries.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester, 3.** 6.30 p.m. Alderman T. A. Edwards, "**Some Adventures of an Amateur Tramp.**"

Mechanical Engineers, Institution of, in the S.W. Institute of Engineers, Park Place, **Cardiff.** 6 p.m. H. Knowler, "**Recent Developments in Flying Boats.**"

United Nations Fellowship, at the Royal Empire Society, W.C.2. 7.30 p.m. T. C. Fairbairn, "**Music – as a universal language.**"

WEDNESDAY, FEBRUARY 12..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5 p.m. G. T. Garwood, "**The Operational Characteristics of Modern H.V. Wood-Pole Lines.**"

At the Heriot-Watt College, **Edinburgh.** 6 p.m. R. A. Smith, "**A Survey of the Development of Radar.**"

Kinematograph Society, British, at the G.B. Theatre Film House, W.1. 7.15 p.m. Marcus F. Cooper, "**The Film in Relation to Television.**"

Petroleum, Institute of, at Manson House, 26 Portland Place, W.1. 5.30 p.m. C. G. Williams, "**Fuels and Lubricants for Aero Gas Turbines.**"

Physics, Institute of, in the Lecture Theatre, Royal Institution. 2.15 p.m. A. J. Philpot, "**New Optical Materials.**"

At the University, **Sheffield.** 5.15 p.m. Dr. C. Sykes, "**Physics and Steel Making.**"

THURSDAY, FEBRUARY 13..Chemical Society, at the University, **Manchester.** 7.30 p.m. Professor M. Stacey, "**Some Aspects of the Chemistry of Fluorocarbons.**"

At **Sheffield University.** 5.30 p.m. Professor J. Monteath Robertson, "**Bond Lengths in Aromatic Hydrocarbons.**"

Dyers and Colourists, Society of, at the Gt. Northern Victoria Hotel, **Bradford.** 7.15 p.m. Dr. H. P. Staudinger, "**Polymer Chemistry.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5 p.m. F. Widnall and R. Newbound, "**The Protective Finishing of Electrical Equipment.**"

At the Royal Hotel, **Dundee.** 7 p.m. P. Schiller, "**Comparisons between Gas and Electricity on the Basis of Coal Economy.**"

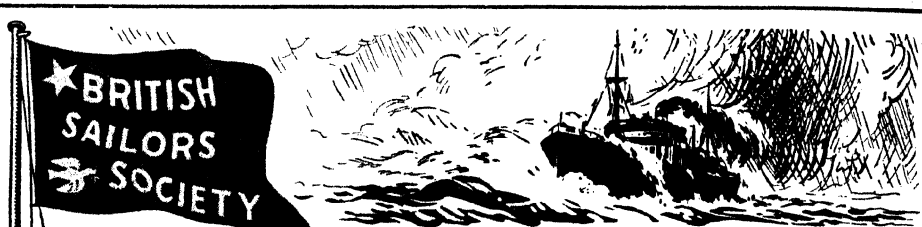
Photographic Society, Royal, 16 Princes' Gate, S.W.7 7 p.m. Percy W. Harris, "**Practical Colour Processes.**"

FRIDAY, FEBRUARY 14..Chemical Engineering Group, at the Geological Society, W.1. 5.30 p.m. G. Eyssen, "**Polyvinyl Chloride and its Co-Polymers.**"

Electrical Engineers, Institution of, at the Caledonian Hotel, **Aberdeen.** W. Fordham Cooper, "**Electrical Control of Dangerous Machinery and Processes.**"

Oil and Colour Chemists' Association, at the Engineers' Club, **Manchester.** 2 p.m. D. H. Hewitt, "**Further Developments in Styrene Co-Polymers.**"

Royal Institution, W.1. 9 p.m. F. I. G. Rawlins, "**Natural Science and the Fine Arts.**"



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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4737 *FRIDAY, FEBRUARY 14th, 1947* Vol. xcv

MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

Ordinary Meetings

Wednesday, February 19th, at 5 p.m.—"A Century of Chemistry". By Sir Harold Hartley, K.C.V.O., C.B.E., F.R.S. Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., LL.D., F.R.S., a Vice-President of the Society, in the Chair. (Joint Meeting with the Chemical Society to commemorate the Centenary of its foundation).

Wednesday, February 26th, at 5 p.m.—"Economic Reconstruction"—(iv) "Finance and the Use of Money". By A. H. Ensor, Chief General Manager, Lloyds Bank, Ltd. The Right Hon. Lord Kennet, P.C., G.B.E., D.S.O., D.S.C., in the Chair.

Dominions and Colonies Section

Tuesday, February 18th, at 2.30 p.m. (*Neil Matheson McWharrie Lecture*).—"Recent Agricultural Developments in Canada". By Lieut.-Colonel J. G. Robertson, B.S.A., Agricultural Commissioner for Canada. Mr. Norman Robertson, High Commissioner for Canada, in the Chair.

India and Burma Section

Thursday, February 20th, at 2.30 p.m. (*Sir George Birdwood Memorial Lecture*).—"The Value of Geological Survey Work in India's Economic Development". By Sir Lewis L. Fermor, O.B.E., F.R.S., formerly Director, Geological Survey of India. Sir Edwin Pascoe, M.A., Sc.D., D.Sc., in the Chair.

CONFERENCE TO DISCUSS THE PROPOSED 1951 EXHIBITION

A full report of the Conference held at the Society's House on February 6th to discuss the proposed 1951 Exhibition will be published in the next issue of the *Journal*. In the meantime it may be stated that a total of 130 organisations accepted the invitation and, in spite of the inclement weather, 101 representatives were present, together with many members of the Council of the Society.

It was evident that the questions brought forward by the Society had been very carefully considered by the organisations participating in the Conference, and a considerable variety of views was expressed. By far the majority were strongly in favour of holding the proposed Exhibition, and of doing so at the earliest possible date. Most representatives considered that 1951 was not only the most desirable date for the Exhibition, but also a practicable one. It was also widely thought that

a scheme of this kind would provide the fillip which was required at the present time to counteract the general feeling of frustration.

There was a greater divergence of view regarding the site for the Exhibition. The majority were in favour of Hyde Park, but there were some enthusiastic supporters of the South Bank scheme and others favoured the Crystal Palace.

A report of the views expressed is being sent, at his own request, to the President of the Board of Trade.

Since the publication of the list of organisations on pages 153–5 the following additional acceptances have been received:

Anglo-Belgian Union (Miss L. B. Dashwood, Secretary).
Anglo-Brazilian Society (Mr. Morgan, Secretary).
Anglo-Swedish Society (Lord Sempill, President).
Incorporated Association of Architects and Surveyors (Major G. B. J. Athoe, Secretary).
Art Workers' Guild (Mr. Percy Delf Smith, Past Master).
Baptist Union (Rev. B. Grey Griffith, B.D., Past-President).
National Association of Boys' Clubs (Mr. G. B. Bradney, Assistant General Secretary).
British Empire League (Sir Lionel Fletcher).
British Employers' Confederation (Mr. R. J. H. Grose).
British Association for Commercial and Industrial Education (Commr. E. Whitehead, General Secretary).
Canadian Chamber of Commerce in Great Britain (Mr. G. H. Ward).
Crystal Palace Trustees (Sir Henry Buckland).
Association of Education Officers (Dr. C. F. Strong, President).
Union of Educational Institutions (Mr. H. L. Tolley, Secretary).
English Speaking Union (Lady Wakehurst, Chairman of Common Interests Committee).
Girl Guides Association (Mr. A. W. Hurll, Gen. Secretary, Boy Scouts Association.
Incorporated Association of Head Masters (Mr. P. A. Wayne).
Home Arts & Industries Association (Mrs. M. Bailes, Secretary).
Industrial Transport Association (Mr. C. Courtney Cramp, Secretary).
Church of Ireland (Archbishop of Armagh, Chairman).
British Society for International Understanding (Mr. Peter Sebastian).
Iron & Steel Institute (Mr. K. Headlam-Morley, Secretary).
Institute of Journalists (Mr. A. T. Penman, President).
London Trades Council (Mr. J. Jacobs, Secretary).
Methodist Church Conference (Rev. A. Stanley Leyland).
Institute of Park Administration (Captain B. H. MacLaren, President).
Royal Agricultural Society (Lieut.-Colonel Sir Archibald Weigall, President).
Royal Geographical Society (Sir George Clerk).
National Association of Schoolmasters (Mr. R. Anderson, Secretary).
Episcopal Church of Scotland (Rev. J. G. Murray).
National Union of Teachers (Mr. J. H. Wooldridge, Member of Executive Committee).
Town & Country Planning Association (Mr. D. Donnelly).
Town Planning Institute (Mr. W. R. Davidge, Past-President).
Trades Union Congress (Mr. G. W. Thomson, Chairman).
Workers' Educational Association (Mr. H. E. Poole, Education Officer).
Workers' Travel Association (Mr. E. W. Wimble, Secretary and General Manager).
Young Women's Christian Association (Miss Rushton).

MARINE LIFE-SAVING APPLIANCES FOR THE MERCHANT NAVY AND FISHING FLEETS

By Captain J. C. TAYLOR
Principal Officer, Marine Surveyors' Office, Ministry of Transport

THOMAS GRAY MEMORIAL TRUST LECTURES

LECTURE I—*Delivered Monday, December 2nd*, 1946

In setting out the various appliances for saving life at sea in ships of the Merchant Navy and Fishing Fleets, it is necessary to indicate that the Ministry of Transport now exercises the powers taken by the State under the Merchant Shipping Acts, which previous to the late War were exercised by the Board of Trade. These powers include, among many others, the requirements of the adoption of devices and measures to enable crews and passengers to escape from a ship in distress with adequate means for their succour and ultimate rescue. Shipping in general follows recognised routes, and help can be readily summoned by wireless should a ship be in collision, stranded, or on fire, yet it must be evident to the ordinary layman that appliances are necessary to safeguard the persons on board the stricken ship until such help arrives at the scene of disaster.

The appliances as required by statute are boats, often referred to as the first line of defence, liferafts, buoyant apparatus, lifebuoys, lifejackets and line-throwing apparatus.

The ship's lifeboat is the shipwrecked mariner's main means to safety and the essential points regarding building and equipment will be taken first. Previous to 1942, when it was decided that all boats carried in compliance with the principal rules and the above quoted rules had to be lifeboats of Class I, the principal rules classified the standard types of lifeboats in the following order :

Class I—Open boats with rigid sides, fitted either
- (*a*) with internal buoyancy only, or
- (*b*) with internal and external buoyancy appliances.

Class II—(*a*) open boats fitted with internal and external buoyancy appliances and the upper parts of sides collapsible, and
- (*b*) decked boats with either fixed or collapsible watertight bulwarks, and

Class III—Open boats constructed in accordance with the provisions of these rules relating to lifeboats of Class I, but not fitted with the internal or external buoyancy appliances of boats of that class.

A working party set up by the Ministry, having considered the numerous war-time requirements, reached agreement that the lifeboats, as classified above, did not quite meet the requirement of to-day, as boats of Class II had not been constructed for use in British ships for a number of years and experience gained during the war had shown Class III boats to be unsuitable for deep-sea work. They agreed that the war-time requirements for the lifeboats in all sea-going ships and passenger ships plying in partially smooth water to be Class I lifeboats should be retained in peace-time, and up to the moment no alteration of this requirement has come into operation, except in the case of fishing vessels and small coasting vessels. Therefore

I will confine my remarks to the Class I lifeboat. Fig. 1 depicts a 30 ft. standard type lifeboat, clinker built, double ended and typical of the lifeboats carried in most ships, especially of the large passenger type.

All boats should be properly constructed, and be of such form and proportions that they have ample stability in a seaway and sufficient freeboard when loaded with their full complement of persons and equipment. The structural strength of all boats must be to the satisfaction of the Ministry of Transport.

At this stage it is worthy of note that during the last war, owing to the rapidity with which ships were liable to sink, it was found necessary to make the launching arrangements in all new ships of sufficient strength to enable the boats to be lowered

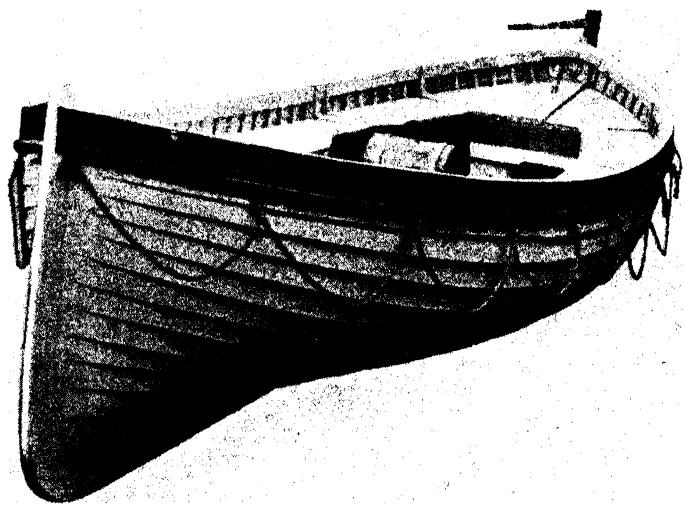


FIG. 1.—*View of standard 30-ft. wooden ship's lifeboat, showing the "sheer"*

into the water fully loaded. This added precaution was very necessary when it is considered that the davits in certain classes of ships were only tested to lower the boat with the minimum number of men on board to attend to the falls while lowering.

The main points with regard to the efficiency of the lifeboat can now be taken. In all open boats all thwart and side seats must be fitted as low in the boat as practicable and bottom boards are to be so fitted that the thwarts are not more than 33 in. above them. The cubic capacity of any boat must be at least 125 cu. ft., but fishing vessels may carry boats 14 ft. in length. No boat will be accepted the buoyancy of which depends upon the previous adjustment of one of the principal parts of the hull (so disqualifying any form of collapsible boat). Every boat is to have a mean sheer (that is, the upward curvature of the boat towards the ends) at least equal to 4 per cent. of its length. Fig. 1 gives a clear indication of the sheer showing the rise of the boat from amidships away towards each end.

The regulations further stipulate that the air cases of every boat shall be so placed as to secure stability when fully laden under adverse weather conditions. Internal buoyancy appliances are to be constructed of copper or yellow metal of not less than 18 oz. to the superficial foot, or of other approved material. Where the buoyancy is built into the boat, onazote (a specially-prepared form of hard expanded rubber) is often used. The buoyancy of a wooden boat of this type is to be provided by watertight air cases, the total volume of which shall be at least equal to one-tenth of the cubic capacity of boat, while the buoyancy of a metal boat of this type is to be not less than that required for a wooden boat of the same cubic capacity and the volume of watertight air cases should be increased accordingly. The additional capacity required, in cubic feet, is one and three-quarter times the weight of the steel hull in hundredweights ($1\frac{3}{4}$ cu. ft. of sea water weigh about 1 cwt.). In lifeboats of Class I (*b*) having internal and external buoyancy appliances, the internal buoyancy is to be provided by watertight air cases, the total volume of which is at least equal to $7\frac{1}{2}$ per cent. of the cubic capacity of the boat. The external buoyancy may be provided by means of cork or any other equally efficient material but buoyancy is not to be obtained by the use of rushes, cork shavings, loose granulated cork or any other loose granulated substance, nor depend by any means upon inflation by air. If the buoyancy appliances are of cork, their volume for a wooden boat shall not be less than 3·3 per cent. of the cubic capacity of the boat; if of any material other than cork, their volume and distribution is to be such that the buoyancy and stability of the boat will not be less than that of a similar boat provided with buoyancy appliances of cork.

In the class of boat in which the buoyancy is carried externally, the cork is built up in slabs pegged together and covered with waterproof canvas. It is not attached directly to the skin of the boat, but is secured in place by two fore-and-aft pieces of wood with hinged iron strips, rendering it portable for examination of the boat's planking and providing an air space to prevent rotting of the boat's planks when the cork is in position. Owing to its wing position, the cork adds to the stability. When the boat is heeled or when more deeply submerged, the buoyancy is increased. Although this boat may be carried in place of Class I (*a*) boats, only relatively small numbers have been adopted by shipowners in this country.

The buoyancy of a metal boat in this class is not to be less than that required for a wooden boat of the same cubic capacity, and the volume of the watertight air cases and of the external buoyancy appliances should be increased accordingly.

Fig. 2 depicts the air cases being placed into the boat. As you will observe, they are practically quadrantal in section. The side benches covering the air cases act as a seat, as shown on the opposite side from the open air-case space. It will be observed that this is a steel boat and the air cases are all of the largest size, and are therefore fitted with handles for facilitating removal.

In ships of Class I, that is, steam ships carrying more than twelve passengers on international voyages, where the number of lifeboats carried in pursuance of the rules is in excess of thirteen, one of such lifeboats must be a motor-boat fitted with wireless telegraphy installation and searchlight; and where the number of lifeboats exceeds nineteen, two must be motor-boats so fitted. The motor-boat must comply with the requirements for a lifeboat of Class I. It carries the same buoyancy

appliances as it would if it had not a motor, and additional ones to counterbalance the excess weight of the motor, searchlight, etc., over the weight of the number of persons which would replace them if they were not fitted.

Proper appliances must be provided for putting the boat into the water speedily, and the boat must carry adequate fuel and be kept ready for use at all times. The motor and its accessories should be suitably enclosed to ensure operation under adverse weather conditions and provision made for going astern. The speed must be at least six knots when fully laden in smooth water.

We come now to the carrying capacity of boats. The number of persons which

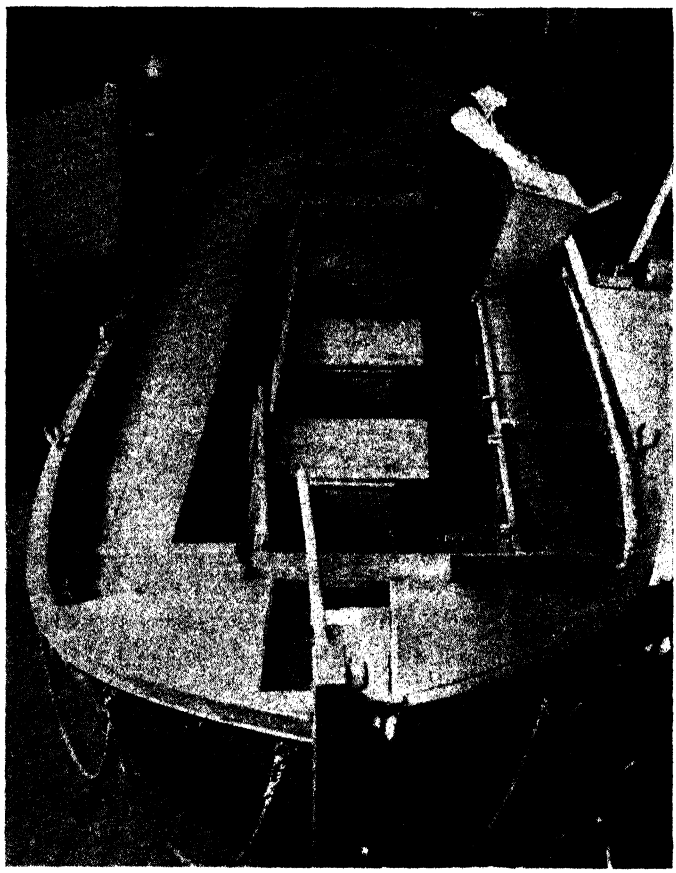


FIG. 2.—*Buoyancy tanks in a steel lifeboat*

a boat is deemed fit to carry is equal to the greatest whole number as ascertained by dividing by ten or nine, as the case may be, the capacity of the boat in cubic feet, determined in accordance with Simpson's first rule formula or by the multiplication of the length, breadth, depth and co-efficient of fineness of the boat, generally assumed to be 0·6. In boats of Class I (*a*) the standard unit of capacity is 10 cu. ft., in Class I (*b*), 9 cu. ft.

When arriving at the number of persons which a boat is deemed fit to carry, that

number must not exceed the number of adult persons wearing lifejackets for which there is proper seating accommodation, arranged in such a way that the persons when seated do not interfere in any way with the use of the oars. Should the surveyor be doubtful at any time as to the number of persons any boat is fitted to carry, he may require it to be tested afloat fully laden with equipment and the intended number of persons all wearing lifejackets.

Fig. 3 depicts a boat being put through the seating test; the number of persons indicated by measurement have been put into the boat and it can be seen they appear to be sitting quite comfortably.

The majority of lifeboats are built of wood on the clincher system. The planking varies in width in the different sizes of boat, but the extreme breadth is not to exceed $5\frac{1}{2}$ in. except in the four strakes next to the keel, with a landing, (*i.e.*, overlap) of not less than $\frac{3}{4}$ in. in breadth to permit of the planks being fastened together with copper nails not more than $3\frac{1}{2}$ in. apart. The planks should be in as long lengths

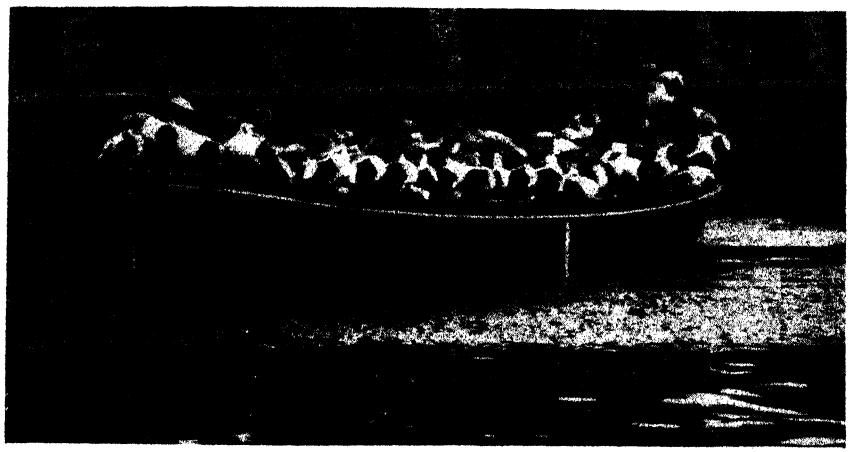


FIG. 3.—*Lifeboat carrying full complement for seating test*

as possible, with an efficient shift of butts (*i.e.*, where the parts of a plank are joined together by scarph), and there must be at least two undisturbed strakes or lengths of planks between butts in the same space bounded by two timbers. Larch and pine are commonly used, but teak and mahogany are used where vessels trade mostly to tropical latitudes. The keel, stem and stern posts are of suitable hardwood, while the keelson, stringers, risings, thwarts and side benches may be of pine. The timbers are of small section, varying from 1 in. to $1\frac{1}{2}$ in., spaced 6 in. apart and being of American elm, ash, oak or teak. The planking is generally worked from keel to gunwale, after which the timbers are steamed, and in that condition are placed in position and pressed into contact with the planking, being then fastened with copper nails. The timbers extend in one piece from gunwale to gunwale except at the ends of the boat. The Ministry have standardised practically all the details for the construction of Class I boats, instructions being issued in book form for the guidance of surveyors, boat builders and any others who are interested.

In some of the large passenger ships with the larger type of boat, the boats were

constructed on what is known as the double diagonal system, the planking being of two thicknesses each at right angles to the other. On occasion the outer planking is worked longitudinally. In this system the timbers are set up on longitudinal ribbands and the inner planking is then fitted, its outer surface being coated with white lead upon which waterproof textile material is stretched, after which the outer thickness

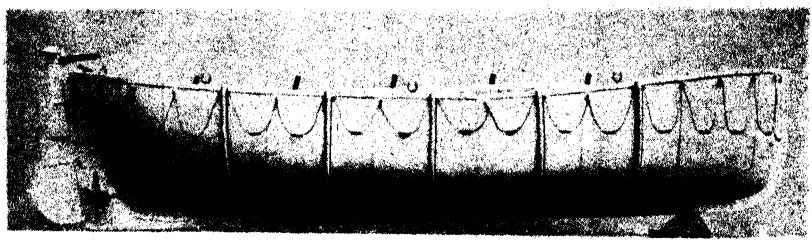


FIG. 4.—*Steel motor lifeboat with welded seams*

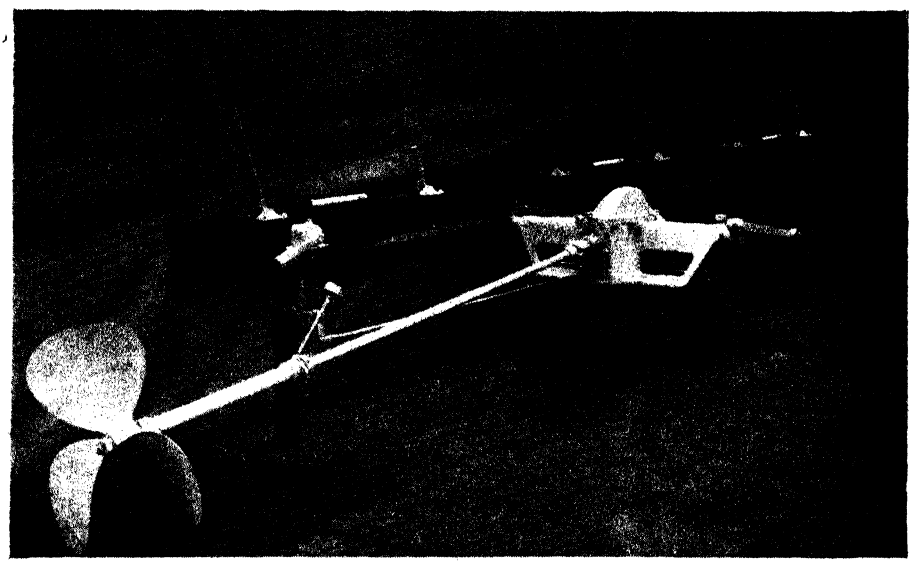


FIG. 5.—*Mechanism of a hand-propelled lifeboat*

is similarly coated in white lead. This system has proved to be very efficient, notwithstanding the climatic conditions to which the boats are exposed.

Of late years the steel boat has superseded this type of boat, as it has been found that a greater capacity can be obtained and one would hazard the suggestion that the cost of the steel boat compares favourably with the double-skinned boat. Fig. 4 depicts a typical steel lifeboat with welded seams. The boat has been fitted with

a motor. It will be observed that the form perhaps is not quite so fine at the ends as that depicted by the standard type wooden boat.

Class I boats constructed to the standard form do not as a rule require to be tested for stability and when constructed to the standard scantlings strength, tests are not usually necessary.

It may be well at this stage to give a brief account of a type of ship's lifeboat which is not too well known, even after nearly twenty years' use, namely, the boat with hand-propelling gear. The arrangement is simple, the propeller being worked by means of levers fitted to fore and aft rods, one at either side, which are geared to the propeller shaft. Fig. 5 shows the machinery, with handles opposite the seats

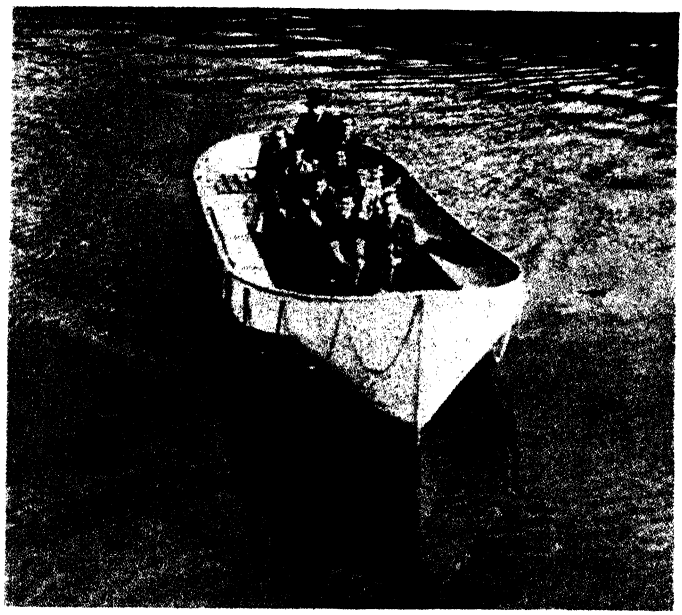


FIG. 6.—*Hand-propelled lifeboat under way*

so that the operators can work amidships and leave the side benches clear for the rest of the shipwrecked passengers or crew.

About eight or ten levers require to be worked in a simple to-and-fro movement, and it is claimed that a speed of about four knots can be obtained, although at first an endeavour was made to obtain six knots. Fig. 6 depicts the boat under way and all handles manned.

No skill is required in this operation. Passengers, even women and children, can "man" the handles and act in place of skilled seamen as far as propulsion is concerned, so that numerous relief crews can be arranged in a boat with a full complement of persons.

It has been claimed for this type of boat that it can be cleared from the ship's side immediately it is waterborne, being entirely in the hands of the coxswain, and can be put under headway or sternway as required. The boats are designed with as much purely straight side as possible, whereby it is claimed that there will be

quicker and safer loading, together with less liability to serious damage in the case of the boat falling against the ship's side.

The carrying capacity of ships' lifeboats has been increased far beyond what was anticipated. This is very evident in the large Atlantic liners of to-day, wherein large boats, built of steel and fitted with diesel engines, carry 150 persons.

At this juncture I would like to mention two lifeboats that are wartime products.

In the early part of 1944 arrangements were made with the Director of Merchant Shipbuilding, Admiralty, for a new pattern lifeboat, known as the "Lowe" lifeboat, to be fitted in new Ministry ships of over 300 ft. in length (excluding tankers) building in the United Kingdom. This boat provided a greater measure of permanent protection for the occupants than does the standard type of lifeboat and was designed to reduce the risk of swamping in the event of uneven lowering. They were not unlike in shape and form the boats as used by the Royal National Lifeboat Institution. There were two sizes, 26 ft. and 24 ft. in length. This boat could be stowed under the majority of the standard types of mechanical davits.

Another boat in use was the steel lifeboat (Mark I) supplied to tankers. The deep-sea tanker carried four special Mark I lifeboats, two of which were propelled by diesel engine and the other two by electric motor or Fleming hand-propelling gear. Those with diesel engines are stowed on opposite sides at midship and poop positions. The set positioning of the boats is to minimise the risk of both diesel engine boats being put out of action simultaneously. The lifeboat is of light steel construction, having 24 built-in buoyancy compartments in continuity all round the sides and ends, in conjunction with a deck at each end and a half deck each side in way of the cockpit.

The cockpit can be completely covered with a fire-resisting canopy, and hand-operated spray pumps can be brought into action to drench the upper parts of the boat, thereby keeping such parts relatively cool when passing through fire.

The boundary bulkheads formed by the buoyancy compartments are extended to form a deep coaming which takes the overlap of the fire-resisting canopy and at the same time affords weather protection to the occupants when the canopy is open. These lifeboats are 28 ft. in length, 9 ft. 6 in. in breadth, 4 ft. in depth and are capable of accommodating 41 persons. The weight of the boat with full equipment, stores, water and full complement of persons on board is $7\frac{3}{4}$ tons when fitted with the diesel engine. It is slightly less when fitted with the electric motor or hand propelling gear.

The natural limitations of the available materials combined with maintenance costs may influence to some extent the design and construction of boats. Wood is used extensively, but the steel boat is appearing in ever increasing numbers. In wooden boats there are a great many fastenings, the efficiency of which depends upon the quality of the timber, and the proper fitting of the many parts. In steel boats, the number of parts is very much reduced, and although there are steel boats being built with riveted seams, the process of welding, which is very much to the fore at present, will further reduce the number of parts. Some steel boats are built without seams in the shell except at the keel, stem and stern posts. Some have welded seams while in others the seams are riveted. In the riveted boat the joints have painted tape worked between the plates to ensure watertightness, since the

steel is only one-sixteenth to one-tenth of an inch in thickness and cannot therefore be caulked; but this system has proved unsatisfactory and there is a strong recommendation for welding. With the thinner plating, transverse frames are fitted either in the form of small angle-iron, or in some cases by transverse corrugations and in others by flanges in the shell plating.

With steel boats it is necessary to galvanise the metal, and this is done by the hot process. It has been found in recent years, however, that the zinc spray is very useful for the total galvanizing of all the metal. In addition, bituminous compositions are used internally and paint externally. To protect wooden boats as far as practicable from dry rot, the effects of atmospheric and climatic conditions and other alterations or variations of moisture and temperature, the surfaces are coated with paints and in some cases varnishes. Whether steel will supplant wood in boat construction as it has done in ship construction is a question for the future. The steel used is ductile and reliable and we have reached the stage of the rustless steel boat.

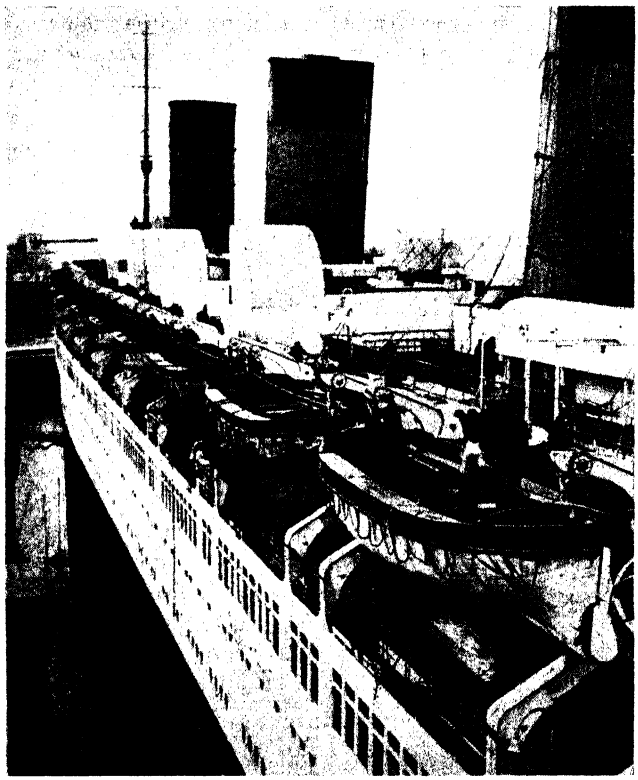
It appears that we have now arrived at the stage in which large lifeboats are likely to be adopted, and who knows but that in the near future interesting developments may take place in regard to the internal arrangements for rendering ships' lifeboats self-righting after a manner of the lifeboats as used by the Royal National Lifeboat Institution, and also as was intended for the "Lowe" type of boat.

Consideration has been given to the class of lifeboats carried by sea-going ships to-day, but it is of great importance that the boats be stowed in such a manner that they will be at all times ready for launching in the shortest possible time and at this stage it will be helpful if I deal with the various points in connection with boat stowage.

Gone are the days when ships' boats were given little consideration as a means of saving of life, and were often put down as a nuisance to the working of the ship's sails—the reason why it was a common sight to see boats stowed in skids bottom upwards. The problem of providing the ideal stowage of the lifeboat depends to a considerable extent upon the davits and launching arrangements, the size of the ifeboats, their proportions and type and upon the absence of obstructions on the boat deck. The introduction of mechanical davits of various designs has greatly improved boat stowage, a set of gravity davits with single wire falls being capable of rapidly launching a lifeboat of the largest type in a very short time. This latter arrangement is such that it permits a considerable amount of promenading space under the boats. The ideal arrangement is that which provides a single row of boats along each side of the ship capable of being launched simultaneously in the shortest possible time, together with arrangements for transporting the boats across the deck to either side of the ship. In many ships the first condition is practicable, but owing to the design and arrangements of present-day ships, the second condition cannot be fulfilled. In addition to suitable positions for speedy launching, there remains the question of securing the lifeboats to ensure that they may not be damaged or come adrift under the conditions which exist when a ship is at sea.

In sea-going ships the lifeboats when stowed are supported in chocks, which are fitted at about one-quarter of the boat's length from each end. These chocks are arranged to hinge on a sole piece, an iron hook being fitted between each chock and sole piece to keep the chocks in position when supporting the boat. In order to

secure the boat in position, gripes are fitted in close proximity to the chocks. These consist of a flat plate which hinges over the gunwale of the boat, having a chain and slip link secured to the outer ends, the lower ends of each chain being secured to an eye plate at the top with a rope lanyard, which may be cut in case the slip links fail, and provides for adjustment when griping the boat down. In such cases these chocks require to be pulled away from the boat to obtain clearance for turning them down. Sometimes, instead of fitting hinges, the chocks are constructed with



(*By courtesy of Keystone Press Agency*)

FIG. 7.—*Modern method of lifeboat stowage with gravity davits* (*R.M.S. "Queen Mary"*)

a wood key or tongue running athwartships which fits into a corresponding groove in the sole piece, allowing the chocks to be slid away from the boat.

Both inboard and outboard chocks are considered necessary where boats are stowed in positions at which seas are likely to break over the boats. When boats are so positioned well above the load waterline, it is possible to dispense with outboard chocks and sole pieces. When this is the case the keel of the boat is griped from the outside by an iron palm at the end of a rod, the inner end of the rod being shaped to form a handle for turning the palm clear of the keel when about to launch the boat. In certain types of mechanical davits and in all gravity types, the arms are so formed that the boat is securely chocked inboard. The boat is released from the chocks just after the falls have been put in motion for lowering. Fig. 7 gives a clear indication of the modern method of stowage with gravity davits.

In ships carrying less than twelve passengers, where the boats on each side are of sufficient capacity to carry all persons on board, the stowage generally takes place abreast the engine-room casing. Coasting ships of the present day with their engines aft are on the increase, and care must be taken to stow the boats sufficiently forward of the propeller to avoid mishap. Suitable arrangements should be made to keep the boats, when being lowered, clear of all discharges of water from the engines, even although there are emergency controls conveniently sited outside the engine room to stop the discharge of heavy water. The stowage of boats must be such as to permit of them being swung out either end first, and it is desirable with the ordinary radial type davit to provide for cases of extreme trim, darkness or other possibilities.

The foreign-going passenger ship carrying large numbers of passengers often provides a knotty problem, but the mechanical davit has made sufficient advance to cover most of the troubles experienced to-day.

We are still faced with the older type of passenger ship and her appliances. In order to overcome the lack of deck space it is permissible to stow one boat within another, subject to certain conditions, principal of which is the method of supporting the upper boat in order to distribute as evenly as possible its weight over the lower boat, the latter being specially strengthened in the way of chocks. The method of gripping the inner boat must not impose any stress on the outer boat liable to cause spreading of the gunwales or any other distortion. In all cases where boats are to be stowed one within the other, full details of the proposed method of stowing and launching the boats must be submitted to the Ministry for approval. The boats must be capable of being put into the water safely and rapidly, even under unfavourable conditions of list and trim, so that as large a number of persons as possible may be got away from the ship rapidly in an emergency; the arrangements should in general provide for the launching of the lower boat first. Boats can only be so stowed in such a way as to require lifting before being launched, if mechanical power appliances for lifting are provided.

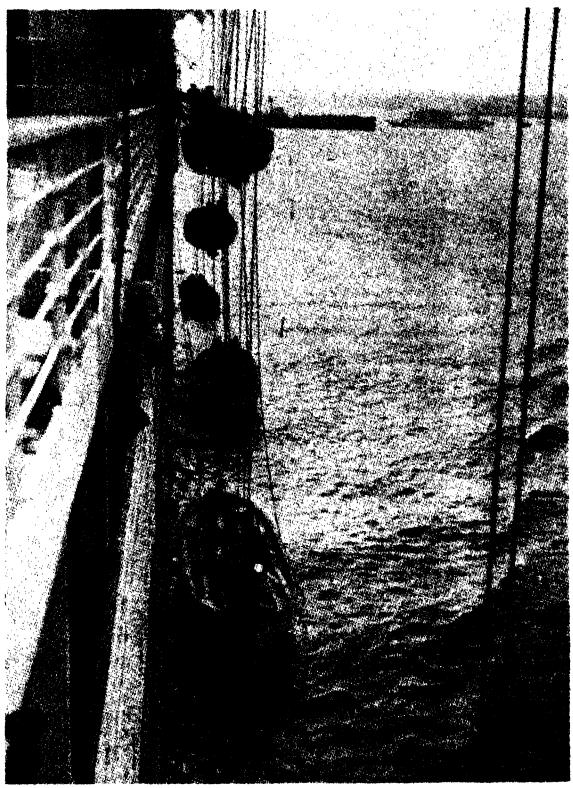
Efficiency of the stowage and launching arrangements of the boats in each case, and of the power appliances for lifting the inner boat and recovering the falls, is to be tested by putting the boats into the water and noting the time taken to perform each operation. The time should approximate to that taken in lowering by similar davits similar boats stowed one above the other. There must be adequate clearance between the boats while passengers are embarking in the outer boat and also when it has been loaded and released from the ship's side preparatory to lowering, and the falls are to be kept attached to the outer boat and ready for service, so that they can be swung out with facility and launched in the shortest possible time. If separate rope falls are provided for operating the inner boat, they are to be kept attached to the davits and to the lifting hooks of the lifeboat. When wire falls are used for operating both boats, independent means of supporting the inner boat are to be provided to ensure that the inner boat will not be lowered inadvertently on top of the outer boat.

Fig. 8 depicts the lowering of boats in a large liner.

The equipment required for ship's lifeboats forms an essential part of this subject. During the war the equipment of lifeboats was kept very prominently

before the eyes of the Ministry, as it was essential to make every provision for the comfort of the shipwrecked, and, as is well known to us all, long voyages in a ship's lifeboat were quite common. Under normal conditions, it does not appear necessary to carry all the war-time equipment; and after careful consideration by the Ministry, in collaboration with the shipping interests concerned, a reduction in the number of items carried has been made to accord with the normal conditions at sea in peace-time, taking full advantage of our war-time experience to retain that part of the equipment which it would still be an advantage to carry.

In addition to the working equipment, such as oars, rudder, mast and sails,



(*By courtesy of Mirror Features*)

FIG. 8.—*Lowering boats from a large liner*

a light sea anchor is provided to assist in keeping the boat's head facing up to the sea, thereby reducing the rate of drift. Fig. 9 depicts a typical collapsible sea anchor with oil bag attached. This type of anchor was really a war-time product. The oil bag is of assistance in rough seas. It has slight perforations in the lower end, and being attached to the lower end of the sea anchor, makes a constant drip of oil into the sea, thereby helping to smooth the heavy white tops on the oncoming seas.

The boat must carry sufficient water to provide 5-6 pints for each person it is certified to carry, and in addition, 14 oz. each of biscuits, barley sugar and condensed milk. It was deemed advisable during the post-war discussions to reduce

the war-time emergency rations wherein biscuits, chocolate, milk tablets and pemmican or other meat were carried. Ships in the Home Trade carried the above requirements with the exception of the barley sugar.

For the purposes of attracting attention, buoyant smoke floats and combined red flares and rockets of the 5-star type are carried. The former gives off a heavy volume of thick yellow smoke, and provides a means of recognition by aircraft flying in the vicinity. For the purposes of signalling to any approaching craft, an electric signalling torch and signalling mirror are provided, and these could with a little ingenuity be augmented by the use of the bucket and oil lamp which are necessary items in the equipment. A small binnacle type compass with a permanent luminous compass card and lubber line must be carried. The first-aid kit provides a unique collection of what is thought to be essential and the packing of this kit is really

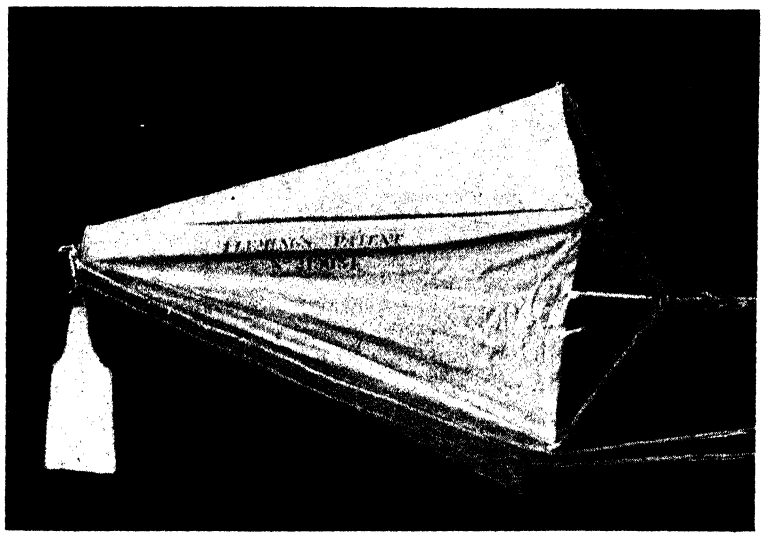


FIG. 9.—*Lifeboat's collapsible sea anchor and oil bag*

a work of art, as to the casual observer the number of items contained in the tin gives the illusion that one or two receptacles must be missing. This is very evident when an attempt is made to replace the articles in the tin.

Charts of the globe with the necessary instruments for use with them provide means of keeping a track and depicting the usual trade routes. There is much useful information on the back of the charts that should be found helpful to the shipwrecked mariner.

The boat's sails are to be red in colour and should have identification symbols painted on them, the symbols to consist of the first and last letters of the ship's name, above which will be a number corresponding to the number in the ship of the lifeboat in question, viz., $\frac{3}{SA}$ — No. 3 boat of S.s. *Sidonia*.

In addition to that equipment already mentioned there are plugs, hatchets, heaving lines and a manual pump. Lockers are provided at each end of the boat, and

occasionally in the amidship part between the air cases, for the storage of all small items, while the water and provisions are carried in special galvanized tanks set in under the thwarts.

A lifeline must be provided. It must be of 2-in. manilla or sisal rope of good quality, having full loops reaching within a short distance of the water-line. The loops must be strongly secured to ringbolts well clenched through the timbers below the rubbing-strake at intervals of not more than 24 in. (See Figs. 1, 2 and 4).

On the bilge of the boat, rails are fitted to permit of men clinging to the boat if upturned, and if necessary climbing on to an upturned boat. (These can be seen in Fig. 4). Lines passing from gunwale to gunwale right under the boat are fitted, but whereas in war-time, water cans were attached to these lines, it is not necessary under peace-time conditions to fit the latter.

In foreign-going passenger and cargo ships, and home trade passenger ships, one of the lifeboats carried and attached to davits was fitted with a motor to provide means of propulsion and to give her a steaming radius of 160 miles. The Ministry of Transport working party considering post-war requirements thought it was no longer necessary for home trade cargo ships of over 2,000 tons gross to carry a motor lifeboat.

The rules require that approved means of launching a lifeboat against an adverse list had to be supplied, and this meant fitting skates on the inboard side of the boat.

Last, but by no means least, comes the lifeboat wireless telegraphy equipment of foreign-going ships on the United Kingdom register. In the latter part of 1944 a Committee appointed by the Ministry of War Transport made recommendations to the effect that the number of portable transmitters and receivers and gear for use therewith carried in foreign-going ships should be increased; that future transmitters should be of the valve type and the manufacture of spark sets should be discontinued on the completion of the then current programme. The new transmitters should be of increased power and should be self-contained with their own source of power; and an alternative source of power should be provided in the lifeboat. The Committee also recommended that in addition to the normal lifeboat equipment, every ship should be provided with one or more dinghy type transmitters. The Ministry adopted the Committee's recommendations, and the lifeboat wireless apparatus hitherto required and the additional apparatus now required were set out in papers issued by the Ministry. Briefly, it can be said that in non-tanker vessels carrying fewer than six lifeboats, two transmitters and two receivers in all were required; and in the same type of vessels carrying six lifeboats or more, three transmitters and receivers, except that in the case of the large passenger ships, the fixed set or sets already fitted in motor boats would be counted against the total of three required. One set of rocket kite aerial equipment was required for each ship. In addition, one hand operated transmitter of the aircraft dinghy type with the associated equipment was required, and when supplies were increased so the number of dinghy sets was increased to two. Aerial topmasts and net aerials were necessary, while a sufficient number of spares was carried to permit of the repair of normal breakdowns.

Reverting back to the working party considering the post-war requirements, they thought that under peace-time conditions, nothing would be gained by adopting

long-range transmission requiring much ancillary equipment. They were of the opinion that the G.P.O. Scientific Department should be officially requested by the Ministry to draw up a specification for an apparatus on the lines of the aircraft dinghy type, for use in cargo ships and in passenger ships carrying not more than thirteen lifeboats, and if practicable to incorporate therein the following features:

(*a*) I.C.W. transmitter.*

(*b*) A valve receiver.

(*c*) A hand generator.

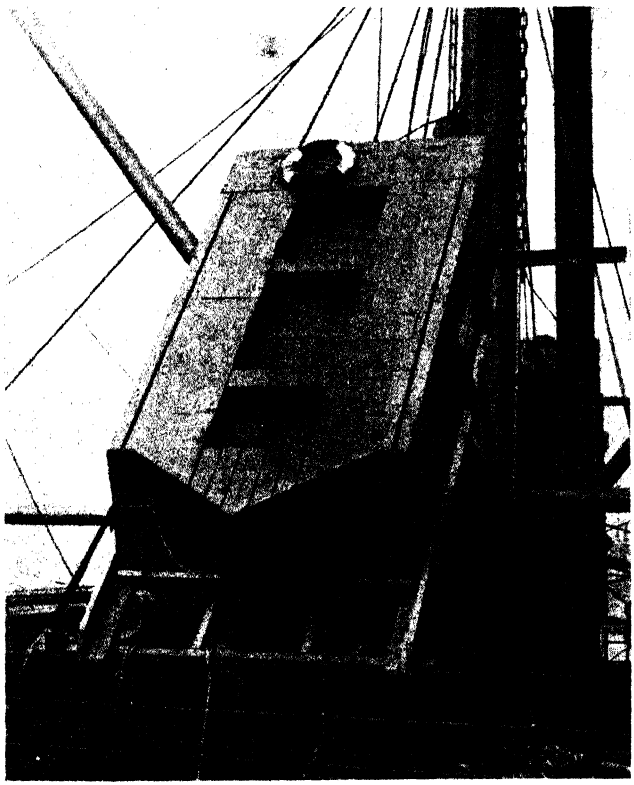


FIG. 10.—*The Chipchase liferaft in its launching ways*

(*d*) A set to be capable of being operated on the 600-metre band from an aerial attached to the lifeboat mast and effective for a daytime radius of approximately 150 miles.

It is pleasing to note that the modern type of equipment is much more reliable and has the added advantage that it can be thrown over the side into the sea and will float.

There is little doubt in the mind of those who go down to the sea in ships that the portable wireless was on many and varied occasions found to be the saviour of life.

*I.C.W. or M.C.W.—Interrupted or modulated continuous wave is a standard method of transmitting Morse code which can be picked up by normal radio-telephony receiver.

It would not be proper to leave the subject of ships' lifeboats without a brief reference to the many fine passages made in these boats during the late war. Many thousands of lives, not only of men of the Merchant Navy, but of members of all the Armed Forces, owe their lives to the ship's lifeboat.

Liferafts

Leaving the ships' lifeboats, I would like to say a few words on liferafts.

Under the rules provision is made for the acceptance of liferafts in certain circumstances. It was not anticipated that it would be desired to carry rafts to any extent as part of the statutory life saving appliances on ships registered in the United Kingdom, but it was thought desirable to lay down certain conditions for the construction of such an appliance.

An approved liferaft should be of approved material and construction effective

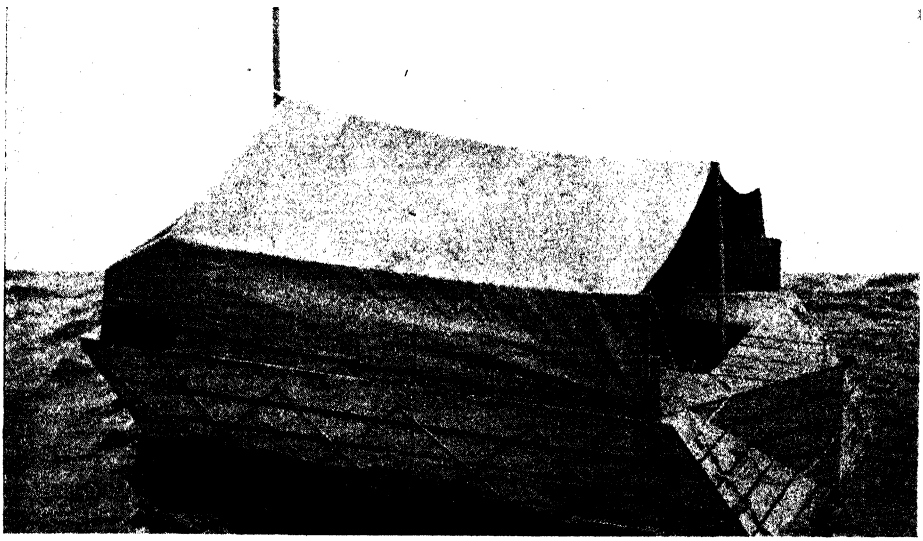


Fig. 11.—*The Chipchase liferaft afloat and fully covered in*

and suitable when floating either way up. The strength of the raft is to be such that it can be launched or thrown from the ship's deck without being damaged; and if intended to be thrown, it should be of such size and weight that it can be easily handled. Buoyancy appliances are necessary to provide 3 cu. ft. for each person to be carried to enable the raft to support the occupants out of the water. The buoyancy appliances must not be dependent on inflation by air.

During the last two wars different types of rafts were brought to the forefront and with the lifeboat were an added means of saving many lives at sea. They were designed to furnish within limits the amenities and to carry the main equipment of lifeboats. They were so stowed as to float off without being launched by hand. It is known that men have survived for weeks in these war-time rafts and been little the worse for their experience and exposure to the weather. Figs. 10 and 11 depict a war-time raft that did much good service. This raft could be completely closed in

to provide weather protection for all (Fig. 11). The inventor gave much thought and energy to its construction, and in his kindly thought for seamen he was pleased to authorise the Ministry to announce that both the raft and his Always Ready Launching Ways for it could be manufactured for use on British ships without payment of royalty and free of any restriction whatever by shipowners and shipbuilders desirous of making use of it.

In conclusion, one is entitled to remark that they proved themselves to be nearly as valuable as a lifeboat, having been the means of saving many lives.

Lecture II—*Monday, December 9th*, 1946

I would like to open to-night with

Buoyant Apparatus

It is many years ago since the Royal Society of Arts started the ball rolling in regard to buoyant apparatus by forming a Committee to consider marine life-saving appliances, in an effort to provide means for saving life in case of sudden disaster. At the same time a Departmental Committee of the then Board of Trade expressed the opinion that certain ships navigating in comparatively crowded waters should be provided with means of keeping every person afloat when in the water for a limited period. The means provided consisted of patent folding boats, rafts, deck seats, etc., and they had to be carried on deck clear of all obstructions. Collapsible boats or approved rafts were recommended for foreign-going ships to make up for the deficiency where boat accommodation could not be provided for all. The minimum aggregate boat capacity now required for foreign-going passenger ships is such that the adoption of liferafts in British ships is not likely under peace-time conditions at sea. Buoyant apparatus, however, is carried in all ships carrying large numbers of passengers. It is not to be expected that such appliances will provide accommodation or shelter, as they are used merely to support persons while in the water clinging to them by the lifelines attached around the sides of the apparatus.

All approved buoyant apparatus must be of approved material and construction effective and stable when floating either way up, as was the case with the raft used during the late war. If the apparatus depends for its buoyancy on air, it must not be constructed in such a manner as to require inflation before use in an emergency. Air cases when fitted, or equivalent buoyancy appliances, must be placed as near as possible to the sides of the apparatus, in the interests of stability.

Fig. 12 depicts the ordinary type of buoyant apparatus; being greater than 12 in. in depth, it will be observed that it has two rows of grablines.

The framework of the apparatus is made up of suitable hardwood, well connected at the corners, but the wood casing or sparring may be of softwood of suitable quality. Grablines are fitted all round the apparatus, having a number of equal loops corresponding to the number of persons for which the apparatus is certified. Each loop has a cork or light wood float, and the depth of the loop when wet should be not less than 6 in. and not more than 8 in. When the apparatus exceeds 12 in. in depth an additional row of grablines is fitted.

A painter is to be provided and secured in such a way as to enable the apparatus to be lowered from the deck to the water. A painter need not be provided to each unit where the height of the stowage position of the apparatus is less than 15 ft. above the load water-line. When the number of units exceeds six they can be grouped into numbers of six and the painter attached to the group. An electric buoy light is carried on each unit, but with the painters, grouping can take place on the same lines.

The number of persons for which any buoyant apparatus is deemed suitable is

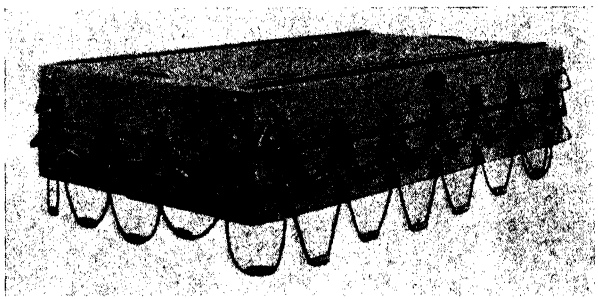


FIG. 12.—*Ordinary type of buoyant apparatus*

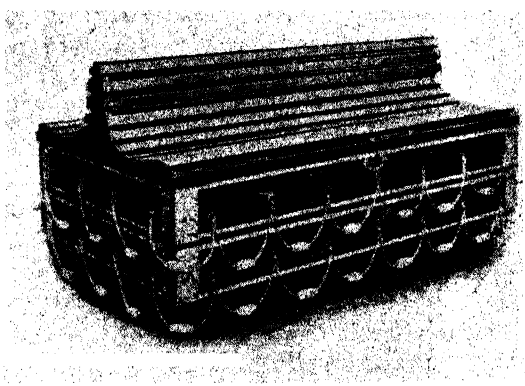


FIG. 13.—*Seat type of buoyant apparatus*

assessed on the basis of (*a*) one person for a weight of 32 lb. of iron supported (in fresh water) or (*b*) one person per foot along its outside edge, where the grablines are attached (always, of course, subject to the stability test as required by the rules). The lesser of these two numbers is taken. It is important to note that buoyant apparatus should have sufficient stability in any position in which it is capable of floating, and no apparatus is acceptable unless it is capable of supporting a weight of iron, suspended in the water from the grablines, of 15 lb. per foot of length, along any edge, without immersing any part of the upper surface of the apparatus. The minimum weight of iron suspended from any edge should be 64 lb., even if the length of the edge is 4 ft. 3 in. or less. For the strength tests the apparatus may be

dropped from heights of from 60 to 20 ft., dependent on the class of ship for which it is required.

Fig. 13 depicts the seat type of apparatus carried in many of the small passenger and excursion ships.

As there are many varied types of construction, it is necessary before approval can be given to any particular type, that detailed drawings and full particulars be submitted to the Ministry, together with the results of tests for flotation, stability and strength and any other tests that the Ministry may deem necessary.

Buoyant apparatus is to be of such size, strength and weight that it can be handled without mechanical appliances, and if necessary, can be thrown into the sea from the vessel's deck on which it is stowed. When the weight exceeds 300 lb., suitable handles or rungs are to be fitted to facilitate the handling of the apparatus. In general, the weight of a single piece should not exceed 400 lb. Should the apparatus be of a special type or of a size which enables increased lifting facilities to be provided and the weight exceeds 400 lb., consideration can be given for its approval. The apparatus must have no projections which would prevent it from sliding easily over the ship's rail in launching, and it must be such that it is always ready for immediate use.

No apparatus which requires adjustment is acceptable, and this can be readily understood when it is considered that the working parts are liable to become ineffective due to the exposed conditions of stowage through all kinds of weather.

As in the case of the lifeboat, the air cases are made of copper or yellow metal of a weight of not less than 18 oz. to the superficial foot. Other durable material may be used subject to the approval of the Ministry. As the buoyancy and stability depend upon the air cases, it is essential that they be frequently inspected and efficiently maintained; for should one of the air cases be rendered non-watertight, the appliance will be very seriously affected both in buoyancy and stability.

Special care is to be taken with the stowage of each unit of buoyant apparatus to ensure that it will be readily available in an emergency and will not interfere with the operation of boats or other buoyant apparatus, or with the marshalling of the persons on board at the embarkation stations or their embarkation into boats. Distribution should be such that the apparatus is placed in suitable positions about the ship, but it must not be stowed in isolated positions from which it could not be launched directly into the water. Buoyant apparatus must not be secured to the deck except by lashings which can be easily slipped. It is permissible to stow the apparatus in tiers one above the other, care being taken that they be kept apart sufficiently to prevent any possibility of their being stuck together by the protecting coverings, and they must be supported on brass or hardwood distance pieces. Means should be provided in the form of wooden stoppers fastened to the deck or some other equally efficient arrangement to prevent buoyant apparatus from sliding across the deck in the event of the vessel taking a heavy list, or pitching or rolling abnormally in a heavy sea. Care is to be taken in the stowage of the buoyant apparatus to ensure that the grablines and floats are not liable to be damaged or to deteriorate and that the apparatus receives adequate ventilation. Buoyant apparatus used on fishing vessels must be of an approved type and such as can be easily stowed.

It may be of interest to note that in foreign-going passenger ships, in addition to

boats for all, buoyant apparatus is to be carried to the extent of 25 per cent. of the total number of persons certified to be carried. During the late war, when our large passenger ships, including the monster *Queen Elizabeth* and *Queen Mary*, were carrying enormous numbers of troops, full use had to be made of buoyant apparatus and it was not an uncommon sight to see many piles stowed throughout the upper decks.

LIFEBUOYS

The lifebuoy, particularly the circular cork type carried by British vessels, is known to most people in this country. In addition to the circular cork type, there are a few other forms of manufacture, chief amongst them being the one used in Dutch ships, namely, the horseshoe shape, which is made of cork or copper. This type is approved for use in British ships, although seldom seen in our vessels. The shape of this buoy has the advantage over the circular type in that it lends itself more easily to fit over the head, by reason of the open end of the horseshoe which provides an entrance for the body ; and a free end of 18 in. of line, fitted at the extremity on one of the legs gives a person the opportunity, if he so wishes, to secure himself into the buoy.

A circular lifebuoy constructed of corrugated copper sheet of 24 gauge has been approved, but again is seldom seen in British ships. Lifebuoys of circular form have an inside diameter of 18 in. and an outside diameter of 30 in. The ring is 6 in. wide and 4 in. thick.

The buoy should be made up of good quality cork securely plugged together and covered by a suitable material, then well coated with paint. Lifebuoys should be painted in good distinguishable colours, such as alternate sectors of red and white. The white buoy is not easily distinguishable under varying conditions and the dual colouring is more suitable as both by day or in a moonlight night the red sectors are conspicuous. The grablines, becketed round the buoy, should be of good quality unkinkable rope, well secured to the cover by sewing or seizing and, in addition, by bands of a double thickness of the covering material, 3 in. wide around the section of the buoy at four equidistant points, providing four loops of line each not less than 28 in. long.

The buoyancy test for the lifebuoy is that it should be capable of floating in fresh water for 24 hours with 32 lb. of iron suspended from it. The weight of the buoy when new is not to exceed 13½ lb. No metal fastenings are to be used in the manufacture to ensure that the buoy is well and evenly formed.

There is also a type of lifebuoy in which kapok is the medium of buoyancy, and others made up of onazote and balsa wood.

Under the Statutory Rules concerning lifebuoys, it was required in all passenger ships that a definite minimum number of lifebuoys should be carried, the number being regulated by the vessel's length. The numbers range from eight in vessels under 200 ft. in length up to thirty for vessels of 800 feet or over. In the foreign-going cargo ship at least six buoys were carried, while in the home trade four. There was a slight alteration to the numbers carried during the war to meet with war-time requirements, but no doubt we will return to the peace-time rules in respect to the lifebuoys.

It is a further requirement in all sea-going vessels that at least half of the lifebuoys required to be carried shall have attached to them a self-igniting lifebuoy light, which must open automatically by the release of the lifebuoy, be self-igniting in water and be capable of burning brightly for at least 40 minutes. The fitting of lights which require the use of a pricker is not acceptable. The lights must be attached by a ring to the rails or other permanent fitting of the ship by means of a small shackle or wire seizing, and to the lifebuoys by a length of good line sufficient to allow a direct drop of at least 12 ft. to release the light; and they must also be encased in such a manner as to protect them from the wind and weather so that they will be efficient at all times.

Every sea-going vessel fitted with a bridge must carry a lifebuoy on or adjoining each side of the navigating bridge in such a manner that they can be released instantaneously so as to drop clear of the ship's side by some method other than lifting the lifebuoy and throwing it overboard. Each of these lifebuoys must have a self-igniting lifebuoy light attached to it as I have described. It is also a requirement of the rules that at least one lifebuoy on each side of the ship is fitted with a lifeline 15 fathoms in length. These lifelines are, however, not to be fitted to the lifebuoys which are arranged for instantaneous release. The lights must always be kept attached to the lifebuoys when the ship is at sea and the beckets of the lifebuoys are to hang free. In the case of oil-tankers, motor ships and oil-fuelled ships, the self-igniting lights as required by the rules shall be of the electric battery type.

The function of the lifebuoy is to act as a handy portable buoyant apparatus to be thrown to the assistance of any unfortunate person who may fall overboard. It is very evident that with proper distribution, there is a reasonable chance of one or more lifebuoys being immediately thrown overboard to a person who has fallen into the sea, and should he be able to reach one of the buoys, he has sufficient buoyant apparatus beside him to keep him afloat until he can be picked up by a rescuing boat.

On occasions it is found difficult to distinguish a person swimming at any distance, even in daylight, and the lifebuoy taking up its natural position of flatness when lying in the water, is not always distinguishable; again, during the hours of darkness there would be no means of locating the position of either the person or the lifebuoy without some guide. It will be readily understood, therefore, why such a light attached to the lifebuoy is necessary. It serves the purpose of providing a guide for the person who has fallen overboard, and it also provides a means for the rescue party to ascertain the position of the lifebuoy, thereby giving the approximate position of the person in the water if he has not already made contact with the buoy. In daytime, in the case of the calcium light, the emission of a volume of smoke while the light is burning, again indicates the position of the lifebuoy, which would in all probability be in close proximity to the person in the water.

It may be of interest to examine the internal arrangements of the lifebuoy light. It consists of a sheet-iron canister of about 7 in. in length, through the centre of which is fitted a metal pin extending from end to end of the canister, projecting about $\frac{1}{16}$ in. at the bottom where the point is soldered over. At the top of the pin is a metal ring which is secured to the ship's rail, awning spar, or other suitable position. At the point where the pin pierces the top of the canister it is connected to the canister

by a strip of soft lead. At the bottom of the canister is another ring for securing the 12 ft. length of line, the other end of which is attached to the buoy.

On the buoy being thrown overboard, its weight immediately comes on to the ring in the bottom of the canister. This weight is sufficient to tear the soft lead cap at the top of the canister as well as the soldering at the bottom, and the canister is then carried downward along with the buoy, leaving the pin behind. Where the lead cap and solder has been broken away, holes are now left, through which the water will enter.

At the upper part of the canister, inside, is a small piece of calcium phosphide, which on contact with water generates phosphene. This gas breaks into flame on coming into contact with air.

There are chambers in the canister which contain calcium carbide, and, as is well known, this substance gives off acetylene gas on contact with water. The small flame caused by the phosphene is sufficient to ignite the acetylene, and so a light is obtained which cannot be extinguished unless entirely submerged. The canister is kept afloat by a sufficient number of air chambers. A certain amount of care and supervision is necessary with these lights as, owing to exposure to the weather, they are liable to corrosion, and should they become rusted through are apt to be ignited inadvertently. A defective canister can, however, usually be detected by the obnoxious smell from the carbide. The canister should be suitably protected from the weather for this reason. Advancing with the times, it is very evident that there is a growing tendency to fit lights of the electric battery type.

Lifejackets

The lifejacket of to-day differs somewhat from the belt introduced over one hundred years ago. To those of you who have made a voyage to sea will come the memory of having seen a lifejacket in your cabin, and on the bulkhead or perhaps behind the door, a card of instructions as to how to fit and adjust the jacket. It is known that in 1806 a lifebelt was invented which appeared to give the wearer when in the water a limited amount of buoyancy. The appliance consisted of a jacket or waistcoat made of leather and dependent upon inflation for its buoyancy. This belt or jacket caused so much interest that in the same year the Society's gold medal was awarded for this invention, but the jacket was never generally brought into use. An improved type was produced four years later and was of the overhead type, that is, it was adjusted by placing it over the head. It is a far cry from 1810, yet the principle of that jacket is very similar to a type of lifejacket in use to-day. In spite of favourable reports, this jacket met the same fate as its predecessor, no doubt due to the fact that it had to be made to fit the individual wearer.

No further development was undertaken until about 1852 when an inspector of lifeboats attached to the Royal National Lifeboat Institution produced a belt of cork. The belt consisted of a large number of small pieces of cork sewn on to a canvas belt. It was designed to support a weight of 28 lb. when floating in the water. This compares favourably with the present-day test of 16½ lb. of iron in fresh water for 24 hours. This belt was an excellent apparatus for the purpose for which it was designed, namely, for the lifeboat service where all the wearers would be

fully grown adults, but was obviously unsuitable for general shipping use, where persons of various sizes had to be considered.

There were many disasters to shipping at sea in which passenger ships were involved, and many lives lost, during the next twenty to thirty years. The Royal Society of Arts, always deeply interested in the encouragement and development of appliances for saving life at sea, came forward with an offer to present their Gold Medal for the year 1878 to any one who could put forward "the best means of saving life at sea when a vessel has to be abandoned suddenly—say with only five minutes warning—the shore or other vessels being in sight". One is led to believe that the Society had in mind an apparatus which would provide efficient buoyancy to a person in the water for a minimum period of time in which it was possible other means of rescue would come to hand, thereby saving many lives. Amongst many appliances submitted, a belt known as the "Soldier's Lifebelt" specially designed for use in troopships, was put forward by the winner of the Gold Medal. This belt consisted of four blocks of cork with a line rove through them, the two ends of which were tied together in front. This belt being designed for a soldier carrying a kit in addition to his rifle, was given buoyancy sufficient to support 40 lb. and weighed 11 lb. It is not known if this type of belt was ever used in our troopships.

It was about this time that the Congress of United States had passed an Act requiring under penalty that all steamers and passenger-carrying vessels should carry "life preservers". The Committee which awarded the Gold Medal expressed the hope that the then Board of Trade would induce Parliament to take action similar to that taken by Congress. It is of interest to note that British ships trading to American ports were provided with a type of lifebelt to comply with the American Act. It was in fact ten years later, in 1888, that the next Rules for Life Saving Appliances were made under the Merchant Shipping Act of that year; it was required by the Act that approved lifejackets should be provided, one for each person on board the ship. The Act required that an approved jacket could be of cork or other suitable material, but it could not depend for its buoyancy upon inflation by air and must be capable of supporting 15 lb. of iron in fresh water for 24 hours. The lifejacket brought into use to satisfy this Act is not much in evidence to-day. It consisted of from eight to ten pieces of cork covered by Tecklenburg linen, with a length of tape at each end for securing the belt on the wearer. It might be said that this jacket was a development of the jacket submitted in 1852 for use with the lifeboat service.

The jacket failed in a necessary ability, that of floating the head and shoulders well clear of the water when the wearer lost consciousness. When wearing this belt the wearer could remain in a vertical position, but as soon as he lost consciousness, the effect of the position of the jacket relative to the body was to allow the head to sag forward into a position with the mouth under the water, this action being due to the centre of buoyancy of the cork being too low relative to the centre of gravity of the body. This fault was made evident after the loss of a large passenger vessel, when a number of bodies were picked up floating face downwards in the water, even although wearing lifejackets. It would be proper to say that the disaster mentioned was responsible for experiments which were carried out with

the object of devising a jacket which would float an unconscious wearer in such a position that the head would be kept out of the water. The officers of the then Board of Trade tested many jackets and approved those which satisfied the required conditions as stated above. The tests clearly demonstrated that to obtain the desired position with an unconscious wearer in the water, the buoyancy of the jacket must be so distributed that the centre of buoyancy must be well above the centre of gravity of the wearer. This condition can be obtained if the bulk of the buoyancy medium is placed above the level of the armpits. The majority of the lifejackets submitted for approval had a preponderance of the buoyancy medium in the front, and this had the effect of floating an inert body in a more or less vertical position but slightly inclined backwards. This placing of the buoyancy medium necessitated the jackets being clearly marked to indicate the back and front, in



(*a*) (*b*)

FIG. 14.—(*a*) *"Standard" lifejacket (centre), war-time life-saving waistcoat (right), "Victory" lifejacket (left).* (*b*) *Rope grip in the "Victory" lifejacket*

addition to which the Rules required that there must be a number of illustrations placed about the ship showing how the lifejackets were to be adjusted. This jacket appeared to cover all the requirements, yet it had not been in use for long before it was found that it was not sufficiently foolproof. Again, after a shipping disaster, a number of bodies were picked up floating in the water face downwards, showing that the wearer had put the jacket on back to front. Once again the requirements were altered and it was made necessary that all jackets to obtain approval in future must be reversible, *i.e.*, the effect must be the same whether put on back to front or *vice versa*. Eventually a jacket was designed to fulfil all the required conditions of the Board or Trade. This was the origin of the "Standard" Lifejacket and the credit for the design belongs to the officers of the then Board of Trade.

The buoyancy medium of this jacket was of cork, but the design was copied for

a similar jacket in which the buoyancy medium was kapok, and this jacket was known as the "Standard Kapok Jacket". (Fig. 14 (*a*)). No application being made for the patent rights of this lifejacket, any manufacturer was at liberty to make it, provided permission was obtained from the Board of Trade. The adjustment of the jacket is simple, as it is only necessary to hold one pad in the hands and throw the other pad over the head so that the head passes through the neck opening. The arms are then passed through the side openings and the two front tapes are drawn tight and tied together. The two tapes at the back will hang loose, as they are not required; the jacket being reversible required tapes both back and front.

We now have a jacket which will support an unconscious person; and it has been fully demonstrated that should the tapes become loose or untied, it makes very little difference to the wearer. Once the jacket is placed over a person's head, it is highly improbable that it would slip off.

Lifejackets are generally tested on an adult weighing from 10½ to 11 stones and on an average sized boy about eight years of age. It must however be clearly understood that lifejackets are expected to comply with the above requirement when worn by persons of all sizes down to small children. A special lifejacket for babies is still in the experimental stage, although one has been approved for use in addition to the standard jacket.

Demonstrations and tests proved that for an average adult when immersed in water with the lungs working normally, the body had practically no weight. To enable the person in the water to breathe it is necessary to keep the head clear of the water; and since the average head weighs 10–11 lb., a buoyant medium of sufficient capacity is necessary to support this weight. The lifejacket, as before stated, is tested to support 16½ lb., therefore it will be appreciated that there is a fair margin of safety to keep the head well clear of the water.

It will be of interest to give a brief comparison of the buoyant properties of cork and kapok. Prime Java kapok will support about fifteen or sixteen times its own weight in water when packed at about 4½ lb. to the cubic foot, whereas cork will support about four and a half times its own weight in water. This, of course, indicates that kapok has a buoyancy value equal to about 3½ times that of cork. It is of great importance that the density of the packing of kapok should be given special attention, as if packed too loosely or too tightly the buoyancy of the jacket will be impaired. A lifejacket whose buoyancy is derived from cork must be capable of supporting 16½ lb. of iron in fresh water for 24 hours, whereas a lifejacket whose buoyancy is derived from kapok must be capable of supporting at least 20 lb. of iron, after floating in fresh water for 24 hours with 16½ lb. of iron attached. The cork used in the manufacture of lifejackets must not weigh more than 12 lb. per cubic foot and must be of good quality, clean and in pieces the size of which must not be less than 10 cu. in. With kapok it must be prime Java of the best quality or other approved grade, well teased, evenly packed and free from seeds or other foreign matter. At least 24 oz. of kapok must be in each lifejacket which derives its buoyancy from this material.

It is left open to the shipowner to carry whichever type he prefers, but not more than two types of lifejacket (as regards method of adjustment) are to be allowed on any ship. It is noticeable how some companies will stick to the cork jacket while

others prefer the kapok. There is little doubt but that the kapok is a much more comfortable jacket to wear and this was very evident throughout the late war, wherein the kapok lifejacket was predominant.

During the late war we learnt by bitter experience that in cases where ships were sunk by enemy action, sufficient time was not always available to enable the crews to don their lifejackets. After due consideration on this point, the Ministry urged the shipowners to provide members of the crews of their ships with a safety appliance which the crew could wear during their period of deck duties when in dangerous waters. It was considered that the most convenient form such an appliance could take was that of a buoyant waistcoat, and it was not long before an appliance known as the Service Waistcoat was submitted, tested and approved by the Ministry.

Fig. 14 (*a*) depicts the waistcoat as used during the war, with a light attached. The waistcoat is fitted just like an ordinary waistcoat, the hands being passed through arm openings and the tapes, as seen in front, firmly tied.

Kapok provided the buoyant medium, and in addition to being an effective life-saving appliance, it was comfortable to wear under an ordinary jacket and would not interfere with the freedom of movement necessary for men engaged in duties about the ship. It assisted in keeping men warm when exposed to extreme cold. This waistcoat was not treated as a substitute for the standard pattern lifejacket, as all ships had to continue to carry a sufficient number of standard pattern life-jackets for all on board.

It may not be known to all that the chief centre of the kapok industry so far as life-saving appliances are concerned is Java, and it has been found that while kapok is grown in different parts of the world, the different varieties vary in value as a buoyant medium. Various tests have proved that the particular kind of kapok grown in Java has the best buoyant properties and this is the only quality allowed by the Ministry to be used in the manufacture of lifejackets. This apparent superiority of the prime Java kapok may be due to the fact that the growers in that country concentrate on the thorough processing and cleanness of kapok and in fact give a guarantee that it will be well processed and free from seeds and other foreign matter, while other growers are not prepared to give such a guarantee. On examination of the kapok as supplied by the different countries, the prime Java stands out in its cleanness and whiteness. We are all well aware of the fact that Java was invaded, and this meant that our main source of kapok supply was stopped. Naturally the stocks of kapok kept dwindling away and could not possibly stand the heavy strain of the supply required for waistcoats and lifejackets. Something had to be done to conserve our stocks and to eliminate the old fault of the head sagging forward when men wearing the waistcoat lost consciousness, therefore it was considered to be very necessary that an attempt be made to combine both appliances. After careful consideration, a lifejacket known as the Victory lifejacket came into being, which practically satisfied both conditions and was very popular. Fig. 14 (*a*) depicts the Victory type of lifejacket. This jacket was given a dual coloured cover—blue and orange—the latter colour being brought into the scheme in an endeavour to assist recognition from the air.

On occasion difficulty had been experienced in dragging a person out of the

water into a lifeboat, and a buoyant rope was attached to the back of the jacket, forming a loop which gave a hand-hold to assist in this operation (Fig. 14 (*b*)). There was the old disadvantage in this type of jacket that it had to be marked with the word "front".

In concluding the subject of lifejackets, may I offer a word of warning that too much care cannot be given to the maintenance of the lifejacket, as it must be kept dry to retain its full efficiency.

Line-Throwing Appliances

It is laid down by the rules that all ships, except vessels plying in smooth water, in estuaries and lakes, rivers and canals, and short distances to sea, when proceeding on a voyage or excursion from a port in the United Kingdom, are required to carry

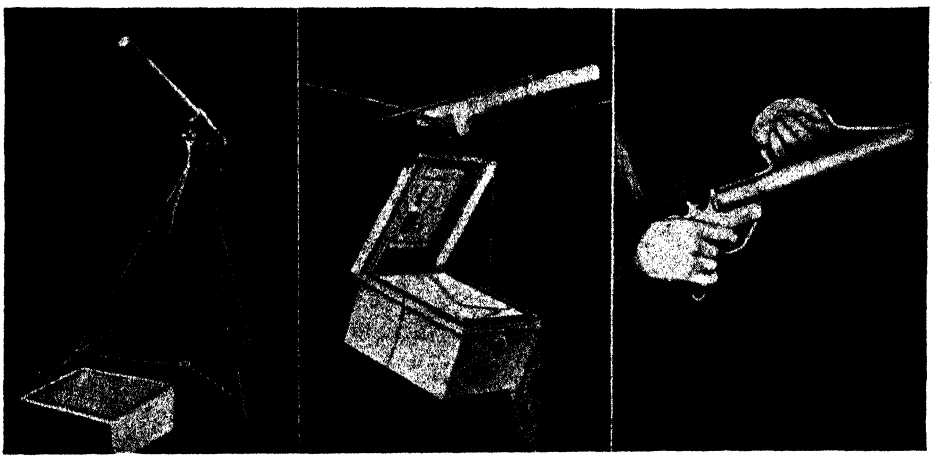


FIG. 15.—*The pistol rocket apparatus, showing three methods of firing*

an approved line-throwing appliance. The fishing vessel is not exempt, as all such vessels of 50 ft. or over in length must comply with the rules.

About the end of the last century the "Ship's Line Throwing Apparatus" was produced, but as in the case of the early type lifejacket, although winning Gold Medals for the invention and receiving enthusiastic support from many people with the interest of the seamen at heart, the majority of shipowners showed little interest. It was just previous to the 1914–18 war that some of the larger shipping companies began to equip their ships with the apparatus, and during the years of war there was a marked increase in the number of ships fitted. In the year 1921 the pistol rocket apparatus (Fig. 15) was invented, and in 1929 an Act came into force making the carrying of line-throwing appliances compulsory for most ships.

In addition to the pistol type there are two portable rocket types. The appliance required by law is to consist of line-throwing rockets with sticks or other approved apparatus capable of throwing a line, the circumference of which should be $\frac{1}{2}$ in., a minimum distance of 200 yd. in the larger type ship and 120 yd. in the smaller type ship in calm weather. The lateral deflection of the line on either side of the direction of firing should not exceed 10 per cent. of the length of the flight of the

rocket. Four rockets and lines make up the outfit, the lines to be not less than 240 yd. for the larger type ship and 150 yd. for the smaller type ship. These lines are tested to a breaking strain of 250 lb.

Fig. 15 depicts the three methods of using the pistol type rocket.

With the pistol type, the largest size is fired from a tripod or supported by a rope, span or rail, while the smaller size pistols can be fired comfortably from the hand owing to the small amount of recoil. The patented method of flaking (Fig. 16)



FIG. 16.—*Firing the portable rocket line-throwing appliance*

ensures a free-running non-kinking line which even under adverse conditions has not been known to foul or break.

Results obtained with the pistol rocket apparatus as regards accuracy, even in the hands of a novice, are no doubt due to the principle of operation and the ease with which it can be aimed. Deflection is remarkably small, rockets falling within a few feet of their targets even when fired athwart a strong wind. The weight of this apparatus ready for firing is small and can be easily handled and operated by any member of the crew, even by a boy. The whole firing act, from opening the generator to the flight of the line-carrying rocket, can be accomplished in less than two minutes.

It is observed that the flare and smoke from the rocket serve as a clear indication

of its course both by day and night, under adverse weather conditions. The pistol rocket starts its flight the moment the trigger is pressed and in the exact direction of one's aim. With the ordinary rocket there may be a very slight time lag before leaving the trough, but this might affect the aim should the vessel have considerable movement. The charge in a pistol cartridge is very small, being only of sufficient strength to propel the rocket for the first few yards of its flight, therefore the recoil is slight, an advantage when firing from a slippery deck, rock or rigging.

The portable rocket line-throwing appliance (Fig. 16) differs from the pistol type in that the rocket is fired from a trough which is attached to the main case. The trough can be adjusted to the desired angle ready for firing, the rocket placed therein, ignitor uppermost, so that the back of the rocket rests against the stop at the rear end of the trough. The rocket is now in position to receive the rocket line, which is made fast at the end, and the box of flake line set in a convenient position for smooth running. Both types of these rockets are fitted by the use of a port fire. To avoid backfire when firing off a rocket, it is recommended that the firer should not stand directly behind the rocket (Fig. 16).

The line-throwing apparatus has served a very useful purpose and has been the means of saving many lives, therefore it behoves all who may require to use it to give every attention to its proper maintenance.

In conclusion, I would express my personal thanks to the Society for the opportunity given to enable me to give you some idea of the appliances put on board ship for the safety of life at sea.

OBITUARY

LADY HELENA GLEICHEN.—We regret to announce the death of Lady Helena Gleichen, O.B.E., on January 28th, at the age of 73. The daughter of Admiral Prince Victor Hohenlohe-Lagenburg, Lady Helena followed an artistic career in common with her brother, Lord Edward Gleichen, and her sister, Lady Féodora Gleichen. Lady Helena received her training at the Calderon School of Animal Painting, and at the school conducted by Mr. Rollshoven and Sir Frank Brangwyn, R.A.

During the war of 1914–18, she served with an ambulance unit in France for ten months, and for two years on the Italian front as Joint Commandant (with Mrs. Hollings) of the British X-ray Section. For her services she received the O.B.E. and an Italian medal for military valour. Her war-time experience also provided a background for her paintings of battle scenes. Lady Helena was a sculptor as well as a painter. In 1940 she published *Contacts and Contrasts*, a book of memoirs illustrated by reproductions of her paintings. She had been a Fellow of the Society since 1936.

HARRY LINLEY RICHARDSON.—The death has been announced, on January 22nd, at his home in New Zealand, of Harry Linley Richardson, F.R.B.A. Born in London in 1878, Mr. Richardson studied at the Westminster School of Art, and in Paris. He exhibited at the Royal Academy in 1900 and 1901, as well as in 1936. In addition to figure and landscape painting, he did a certain amount of illustration in books and magazines, and was responsible for New Zealand stamp designs. He had been director of the Art Department, Palmerston North Technical School, New Zealand, since 1928. He became a Fellow of the Royal Society of Arts in 1939.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

TUESDAY, FEBRUARY 18..Chadwick Trust, at 26 Portland Place, W.1. 2.30 p.m. Professor S. P. Bedson, "**Laboratory Investigations in the Diagnosis of Virus Infections of Man.**"

East India Association, at the Caxton Hall, S.W.1. 2.30 p.m. Lieut.-Gen. Sir Thomas Hutton, "**The Planning of Post-War Development in India.**"

Mechanical Engineers, Institution of, Storey's Gate S.W.1. 3 p.m. Dr. A. Nadai, "**The Flow of Metals under Various Stress Conditions.**"

Petroleum, Institution of, at the Engineers' Club, **Manchester.** 6 p.m. A. E. Hope, "**Illustrated Dissertation on the Use of Petroleum Additives.**"

Physics, Institute of, at the University, **Glasgow.** Mr. A. J. Maddock, "**Dielectric Heating.**"

University of London, King's College. Professor J. T. Randall, "**A Physicist's Approach to Biology.**"

WEDNESDAY, FEBRUARY 19..Civil Engineers Institution of, at the Municipal Annexe, **Liverpool** 6 p.m. J. C. King, "**The Static and Dynamic Testing of Aircraft.**"

Electrical Engineers, Institution of, W.C.1. 5.30 p.m. H. Davis, "**The Design of High-Fidelity Disc-Recording Equipment.**"

At the Neville Hall, **Newcastle-on-Tyne.** 6.15 p.m. J. Hacking, "**The Generation and Wholesale Distribution of Electricity.**"

At Royal Victoria Station Hotel, **Sheffield.** 6.15 p.m. W. Fordham Cooper, "**Electrical Control of Dangerous Machinery and Processes.**"

Foundrymen, Institute of British, at the Waldorf Hotel, W. 7.30 p.m. F. Cousans, "**Co-operation for Control and Research.**"

THURSDAY, FEBRUARY 20..Chemical Society, Burlington House, W.1. 7.30 p.m. (1) W. E. Garner, "**The Reduction of Oxides by Hydrogen and Carbon Monoxide.**" (2) H. W. Melville and R. F. Tuckett, "**The Photochemical Polymerisation of Vinyl Acetate Vapour,**" and (3) "**Radical Sensitised Polymerisation of Vinyl Acetate Vapour.**"

At the University, **Liverpool.** 5 p.m. Professor E. L. Hirst, "**Recent Developments in the Chemistry of Starch and Glycogen.**"

At the University College, **Nottingham.** Professor E. G. Cox, "**Crystal Analysis and Stereochemistry.**"

Electrical Engineers, Institution of. 5.30 p.m. J. R. Mortlock and C. M. Dobson, "**Neutral Earthing of Three-Phase Systems.**"

Fuel, Institute of, at Radiant House, Bold Street, **Liverpool.** 2.30 p.m. Dr. E. G. Ritchie, "**A Review of the Work of R16 Committee.**"

Mechanical Engineers, Institution of, at the College of Technology, **Manchester.** 2.30 p.m. Dr. A. Nadai, "**The Flow of Metals.**"

Radio Engineers, British Institution of, at the London School of Hygiene and Tropical Medicine W.C.1. 6 p.m. J. A. Sargrove, "**A.C. Behaviour of the Barrier-Layer Photo Cell.**"

Road Transport, Institute of, at the Royal Society of Arts. 6 p.m. A. R. Thursby, "**Paints for Road Transport.**"

FRIDAY, FEBRUARY 21..Chemical Society, at the University College, **Southampton.** 5 p.m. Sir Ian Heilbron, "**The Chemistry of Vitamin 'A'.**"

Dyers and Colourists, Society of, at the Gas Department Showrooms, **Manchester.** 6.30 p.m. G. S. Egerton, "**The Aspect of Light on Dyed and Undyed Cotton.**"

Electrical Engineers, Institution of, W.C.2. 5.30 p.m. W. D. Owen, "**Quantitative Tests on Finished Mouldings.**"

Mechanical Engineers, Institution of, Storey's Gate S.W.1. 5.30 p.m. E. L. Diamond, "**Locomotive Power at Speed.**"

Royal Institution, W.1. 9 p.m. Professor M. L. Oliphant, "**Problems and Technique of Modern Nuclear Physics.**"

SATURDAY, FEBRUARY 22..Horniman Museum, S.E.23. 3.30 p.m. Major G. M. Coombs, "**The Hawaiian Islands.**"

Chemical Engineers, Institution of, College of Technology, **Manchester.** 3 p.m. V. G. Jenner, "**Fuel Economy in a Small Factory.**"

MONDAY, FEBRUARY 24..Dyers and Colourists, Society of, at the Technical College, **Bradford.** 7.15 p.m. C. O. Clark, "**Use of Fullers Earth in the Wool Manufacturing Industry.**"

Electrical Engineers, Institution of, W.C.1. 5.30 p.m. Professor H. M. Barlow, "**Hot-Cathode and Cold-Cathode Discharge-Tube Lighting.**"

At the James Watt Memorial Institute, **Birmingham.** 4 p.m. G. L. Grisdale and R. B. Armstrong, "**Tendencies in Design of Communications Type Receivers.**"

At the Neville Hall, **Newcastle-on-Tyne.** 6.15 p.m. G. T. Garwood, "**The Operational Characteristics of Modern H.V. Wood-Pole Lines.**"

At the Corporation Electricity Showrooms, **Rugby.** 6.45 p.m. L. H. A. Carr, "**The Teaching of the Principle of Electrical Machine Design.**"

Geographical Society, Royal, S.W.7. 8 p.m. Mlle. Ella Maillart, "**Afghan Nomads.**"

Rubber Industry, Institution of the, at the Engineers' Club, **Manchester.** 6.15 p.m. H. C. Harrison, "**The Extrusion of Rubber.**"

TUESDAY, FEBRUARY 25..Architects, Royal Institute of British, W.1. 6 p.m. Edward Armstrong, "**Urban Housing—Planning for Amenity.**"

Chemical Society, at the University, **Leeds.** 5 p.m. Professor Wilson Baker, "**The Chemistry of Penicillin.**"

Electrical Engineers, Institution of, W.C.1. 5.30 p.m. B. N. MacLarty, "**The Economics of Transmitting Station Design.**"

At Queen's University, **Belfast.** 6.45 p.m. J. Hacking, "**The Generation and Wholesale Distribution of Electricity.**"

At the Cavendish Laboratory, **Cambridge.** 6.30 p.m. E. S. Shire, "**The Use of Electronics in Nuclear Physics.**"

At the Corporation Electricity Department, **Leeds.** 6 p.m. G. Haefely, "**The Growing Importance of Plastics in the Electrical Industry.**"

University of London, King's College. Professor A. D. Ross, "**Civil Engineering in the University.**"

WEDNESDAY, FEBRUARY 26..Dyers and Colourists, Society of, at the College of Art and Technology, **Leicester.** 7 p.m. Dr. F. Townend, "**The Use of Acids in Wool Dyeing.**"

Manchester Metallurgical Society, at the Engineers' Club, **Manchester.** 6.30 p.m. J. F. B. Jackson, "**Centrifugal and Precision Casting for Aircraft and Aircraft Engines.**"

THURSDAY, FEBRUARY 27..Chemical Society, at the University, **Sheffield.** 5.30 p.m. Professor D. H. Hey, "**Homolytic Relations.**"

Electrical Engineers, Institution of, at the Engineers Club, **Manchester.** 6 p.m. D. C. Espley, E. C. Cherry and M. M. Levy, "**The Pulse Testing of Wide-Band Networks.**"

Preceptors, College of W.C.1. 5.45 p.m. A. Arkinstall, "**The Film Strip and Kindred Aids in the Primary School.**"

Transport Association, Industrial, at the County Hotel, **Newcastle.** 7 p.m. A. L. Bagley, "**Transport Problems of a Mail Order Trader.**"

FRIDAY, FEBRUARY 28..Manchester Statistical Society, at 16 St. Mary's Parsonage, **Manchester.** 6.30 p.m. L. H. C. Tippett, "**Analysis of Variance.**"

Physics, Institute of, at 2 Savoy Hill, W.C.2. 6.30 p.m. E. van Someren, "**Continental Wartime Developments in Spectroscopic Technique.**"

Rheologists' Club, British, at the University, **Birmingham.** 6 p.m. Dr. E. Orowan, "**The Mechanisms of Phase Transformations in Solids.**"

Royal Institution, W.1. 9 p.m. V. S. Pritchett, "**Aspects of the Modern Short Story.**"

Sound Recording Association, British, at the Royal Society of Arts. 7 p.m. L. E. C. Hughes, "**Problems of Sound Reproduction.**"

SATURDAY, MARCH 1..Horniman Museum, S.E.23. 3.30 p.m. Major Charles Howard, "**Across French North Africa.**"

Rheologists' Club, British, at the University, **Edgbaston.** (1) 10 a.m. Dr. Hugh O'Neil and Mr. W. G. Gurney, "**Practical aspects of Hardness Measurement.**" (2) 2.30 p.m. **General Survey.**

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4738 *FRIDAY, MARCH 14th, 1947* Vol. XCV

MEETINGS DURING THE NEXT FORTNIGHT

ORDINARY MEETINGS

WEDNESDAY, MARCH 19TH, at 5 p.m. (*Cadman Memorial Lecture*)—"BRITISH COALMINING AND THE INDUSTRIAL REVOLUTION; WITH SPECIAL REFERENCE TO THE LIFE AND WORK OF THE LATE LORD CADMAN". By Professor Douglas Hay, M.C., B.SC., M.I.C.E., Chief Mining Engineer, National Coal Board. Lord Hyndley, G.B.E., Chairman of the National Coal Board, in the Chair. (Illustrated by lantern slides and a cinematograph film.)

WEDNESDAY, MARCH 26TH, at 5 p.m.—"FLAX UTILISATION". By A. J. Turner, M.A., D.SC., Director of Research, Linen Industry Research Organisation. Ernest W. Goodale, C.B.E., M.C., a Past-President of the Textile Institute, in the Chair. (Illustrated by lantern slides.)

DOMINIONS AND COLONIES SECTION

TUESDAY, MARCH 18TH, at 2.30 p.m.—"WHITHER SOUTH AFRICA?—AN ECONOMIC APPROACH". By S. Herbert Frankel, M.A., PH.D., D.SC.(ECON.), Professor of Colonial Economic Affairs, University of Oxford. Mr. E. K. Scallan, Acting High Commissioner for the Union of South Africa, in the Chair.

CANTOR LECTURES

MONDAY, MARCH 17TH, and MONDAY, MARCH 24TH, at 5 p.m.—(Second and third of three lectures). "ENZYMES: THEIR ISOLATION, STRUCTURE, MODE OF ACTION, AND PLACE IN NATURE". By J. A. V. Butler, D.SC., of the Courtauld Institute of Biochemistry.

SYLLABUS

Lecture II.—Their constitution and mode of action. Mechanism and speed of enzyme action. Enzymes in which working groups have co-enzymes. Inter-relations between enzymes and vitamins. Bacterial inhibitors and antagonists. Enzymes and trace elements.

Lecture III.—Their place in nature. Enzymes without prosthetic groups. Controlling factors. Variety and specificity. Origin of enzymes and the gene.

MEETING OF COUNCIL

A meeting of the Council was held on Monday, February 10th, 1947. Present: Sir Edward Crowe (in the Chair); Lord Aberconway; Lord Amulree; Mr. F. H. Andrews; Sir Frank Brown; Major W. H. Cadman; Mr. E. W. Goodale; Miss Caroline Haslett; Dr. R. W. Holland; Sir Thomas Holland; Sir Harry Lindsay; Mr. J. A. Milne; Mr. Keith Murray; Sir Ernest Pooley; Mr. J. W. Ramsbottom; Mr. E. M. Rich; Mr. A. R. N. Roberts; Mr. E. Munro Runtz; Lord Samuel; Sir Frank Smith; Mr. William Will and Mr. J. G. Wilson; with Mr. K. W. Luckhurst (Secretary) and Mr. C. Burns (Assistant Secretary).

The results of the Conference held on February 6th to discuss the proposed International Exhibition were assessed, and the nature of the report to be made to the President of the Board of Trade was determined upon.

It was decided to postpone the annual Industrial Art Bursaries Competition until the Autumn.

It was reported that 59 entries had been received for the Colombo Cathedral Competition, and that judging was about to commence.

Preliminary consideration was given to the award of the Society's Albert Medal for 1947.

Mr. Basil Ionides was re-appointed the Society's representative on the Board of Architectural Education of the Architects Registration Council.

A quantity of formal and official business was transacted.

The following were duly elected Fellows of the Society:

Baldwin, Air Marshal Sir John, K.B.E., C.B., D.S.O., D.L., Stamford, Lincs.
Bramley, Jack Heap, Wakefield, Yorks.
Burton, Harold, PH.D., D.SC., Leeds.
Campbell, Colin, D.SC., Manchester.
Carter, Herbert Desmond, Brooklands, Cheshire.
Cartwright, Walter, Leek, Staffs.
Coomber, Stephen Edward, B.SC., Reigate, Surrey.
Coursey, Philip Ray, B.SC., Liss, Hants.
Cross, Percy Edward, March, Cambs.
Dudley, Leslie Peter Clarence Jack, Twickenham, Middx.
Duerden, Frank, London.
Everard, Captain Patrick Anthony, Windsor, Berks.
Foulkes, Miss Mary Hamilton, Ashton-under-Lyne, Lancs.
Fynne, Professor Robert John, Dublin.
Gibson, Sir William Waymouth, LL.M., Newcastle-upon-Tyne.
Gourlay, Lieut.-Colonel Clifford White, London.
Green, Edgar, Chipstead, Surrey.
Hall, Sir John Hathorn, K.C.M.G., Entebbe, Uganda.
Kulkarni, Gangadhar Babaji, LL.B., London.
Lingham, S. V., Madras, India.
Martin-Bates, James Patrick, M.A., Witney, Oxfordshire.
Matthews, Marcus Aurelius, D.SC., London.
Matthews, Vivian Wilfred, London.
Notley, Captain Leslie Edwin Malcolm, London.
O'Donnell, Mrs. Joan Lilian, Salford, Lancs.
Partridge, John Henry, B.SC., PH.D., Pinner, Middx.
Pike, John Percy, Johannesburg, South Africa.
Rees, Iestyn James, Bridgend, Glam.

Summers, Major John David; Moreton-in-the-Marsh, Glos.
Turner, Alexander Wakefield, Guildford, Surrey.
Walker, Winston, Whitley Bay, Northumberland.
Watkins, Brigadier Harry Reginald B., Tiverton, Devon.
Webber, Richard Alan, London.
Webster, Harold Haig Butler, Port-of-Spain, Trinidad.

The following was duly elected an Associate of the Society:

Cofman-Nicoresti, David, Gainsborough, Lincs.

THE ALBERT MEDAL

The Council will shortly proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1947. They therefore invite Fellows of the Society to forward to the Secretary the names of such men of high distinction as they may think worthy of this honour. These names should reach the Secretary not later than Saturday, April 5th. The medal was struck to reward "distinguished merit in promoting the Arts, Manufactures and Commerce," and has been awarded as follows in previous years:

1864. Sir Rowland Hill, K.C.B.
1865. His Imperial Majesty Napoleon III.
1866. Michael Faraday.
1867. Sir W. Fothergill Cooke and Sir Charles Wheatstone.
1868. Sir Joseph Whitworth.
1869. Baron Justus von Liebig.
1870. Vicomte Ferdinand de Lesseps, HON. G.C.S.I.
1871. Sir Henry Cole, K.C.B.
1872. Sir Henry Bessemer.
1873. Michel Eugene Chevreul.
1874. Sir C. W. Siemens.
1875. Michael Chevalier.
1876. Sir George B. Airy, K.C.B.
1877. Jean Baptiste Dumas.
1878. Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B.
1879. Sir William Thomson (afterwards Lord Kelvin), O.M.
1880. James Prescott Joule.
1881. Professor August Wilhelm Hofmann.
1882. Louis Pasteur.
1883. Sir Joseph Dalton Hooker, K.C.S.I.
1884. Captain James Buchanan Eads.
1885. Sir Henry Doulton.
1886. Samuel Cunliffe Lister (afterwards Lord Masham).
1887. HER MAJESTY QUEEN VICTORIA.
1888. Professor Hermann Ludwig von Helmholtz.
1889. John Percy.
1890. Sir William Henry Perkin.
1891. Sir Frederick Abel, BT., G.C.V.O., K.C.B.
1892. Thomas Alva Edison.
1893. Sir John Bennet Lawes, BT., and Sir Henry Gilbert.
1894. Sir Joseph (afterwards Lord) Lister
1895. Sir Isaac Lowthian Bell, BT.
1896. Professor David Edward Hughes.
1897. George James Symons.
1898. Professor Robert Wilhelm Bunsen.
1899. Sir William Crookes, O.M.
1900. Henry Wilde.
1901. HIS MAJESTY KING EDWARD VII.
1902. Professor Alexander Graham Bell.
1903. Sir Charles Augustus Hartley, K.C.M.G.
1904. Walter Crane.
1905. Lord Rayleigh, O.M.
1906. Sir Joseph Wilson Swan.
1907. The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I.
1908. Sir James Dewar.
1909. Sir Andrew Noble, K.C.B.
1910. Madame Curie.
1911. The Hon. Sir Charles Algernon Parsons, K.C.B.
1912. The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O.
1913. HIS MAJESTY KING GEORGE V.
1914. Chevalier (afterwards Marchese) Guglielmo Marconi, G.C.V.O.
1915. Sir Joseph John Thomson, O.M.
1916. Professor Elias Metchnikoff.
1917. Orville Wright.
1918. Sir Richard Tetley Glazebrook.

1919. Sir Oliver Joseph Lodge.
1920. Professor Albert Abraham Michelson.
1921. Sir J. Ambrose Fleming.
1922. Sir Dugald Clerk, K.B.E.
1923. Major-General Sir David Bruce, K.C.B., and Colonel Sir Ronald Ross, K.C.B., K.C.M.G.
1924. H.R.H. The Prince of Wales, K.G
1925. Lieut.-Colonel Sir David Prain.
1926. Professor Paul Sabatier.
1927. Sir Aston Webb, G.C.V.O.
1928. Sir Ernest Rutherford (afterwards Lord Rutherford), O.M.
1929. Sir J. Alfred Ewing, K.C.B.
1930. Professor Henry E. Armstrong.
1931. H.R.H. The Duke of Connaught and Strathearn, K.G.
1932. Frank (now Sir Frank) Brangwyn.
1933. Sir William Llewellyn, G.C.V.O.
1934. Sir Frederick Gowland Hopkins.
1935. Sir Robert A. Hadfield, BT.
1936. The Earl of Derby, K.G.
1937. Lord (now Viscount) Nuffield, O.B.E.
1938. Her Majesty Queen Mary.
1939. Sir Thomas H. Holland, K.C.S.I., K.C.I.E.
1940. John A. Milne, C.B.E.
1941. President Franklin D. Roosevelt.
1942. Field-Marshal J. C. Smuts.
1943. Sir John Russell.
1944. Sir Henry Tizard, K.C.B.
1945. Winston Spencer Churchill.
1946. Sir Alexander Fleming, F.R.S., and Sir Howard Florey, F.R.S.

SUSPENSION OF PUBLICATION OF JOURNAL

In common with other periodicals, the *Journal of the Royal Society of Arts* has been temporarily suspended from publication during the fuel crisis. The present number is therefore consecutive with that of February 14th, and contains matter which would otherwise have been printed on February 28th.

CONFERENCE ON THE PROPOSED 1951 EXHIBITION

The Conference convened by the Society to discuss the proposed 1951 Exhibition was held at the Society's House on Thursday, February 6th, at 11 a.m. The Right Hon. Viscount Bennett, K.C., P.C., LL.D., President of the Society, was in the Chair. The Conference was attended by delegates from a large variety of organisations which had been invited to send representatives. A full list of those actually present will be found on page 238.

The Chairman, in opening the Conference, and welcoming the delegates, said: I have, first of all, to thank you for coming here, in inclement weather, in such numbers. I have, secondly, to remind you that in this very room were laid the foundations of the effort which resulted in the Exhibition of 1851. For it was here that the Society of that day held a series of exhibitions of British manufactures, which culminated in the Great Exhibition. The great force behind that proposal was the Prince Consort. As you all know, he it was who gave the movement that vigour which made it a real international event. The fact is that it would not have been an international exhibition had it not been for the attitude taken by the Prince Consort. It became a great success, and it is natural, of course, that this Society should now be thinking of the possibility of another Exhibition in 1951. A small committee was recently set up, which, under the Chairmanship of Lord Samuel, met the President of the Board of Trade and outlined to him the Society's proposals regarding the calling of this meeting.

The memorandum which accompanied the invitations that were sent out clearly indicated, I think, our purpose; and in view of the fact that there is much

to be done, I do not propose to make any observations at this stage, in order that you may have the time to discuss the matters that have brought us together.

I will call upon Lord Samuel, in the first instance, to address us, because he has taken a tremendous interest in this matter. I ventured to tell him that I had always had a great admiration for his intellectual power, but I have even more for his driving power. We owe him a great debt of gratitude for all he has done.

Without further observations on my part, I call upon Lord Samuel.

VISCOUNT SAMUEL, P.C., G.C.B., G.I.E.: My Lord President, Ladies and Gentlemen: I have really been called upon because I have the honour to be one of Lord Bennett's Vice-Presidents, and also Chairman of the Sub-Committee which has been dealing with this matter of a proposed Exhibition in 1951. The sub-committee is greatly gratified at the very large number of acceptances to the invitation of the Royal Society of Arts and the attendance of so many to-day, making this a thoroughly representative Conference.

A memorandum has been circulated to all of you stating the case with regard to the proposal for the Exhibition, considering the difficulties that have been advanced and suggesting some ways of meeting them. Therefore, I do not propose to cover the ground generally, since the facts are familiar to you. My observations will be exceedingly brief in order to give as much opportunity as possible for a number of those present to express their individual opinions.

I would, in a few words, summarise the main purposes which the Society has in view in recommending to your consideration this proposal. The greatest emphasis is placed, not so much on the commercial as on the cultural value of an Exhibition of this kind. We feel, as no doubt you all feel, that in the present juncture of human affairs what the world needs above all is confidence and encouragement—that there is a need for leadership (something positive and constructive), in order to bring it clearly before all mankind that, after all, our age has great achievements although it has suffered great disasters. Perhaps in a movement of this kind this country more than any other in Europe is in a position to take the initiative and to offer that leadership. That is the first consideration in our minds.

Secondly, this is a period when the more we can renew the international contacts that were temporarily severed by the war and strengthen them, the more we can get the world to regard itself as one world, the better it will be for all countries. The establishment of the United Nations may perhaps be regarded by future historians as the greatest event in the history of mankind, since for the first time, all the nations will have come together in order to establish some form of world government and control. It is most desirable that international contacts in all directions should, as I say, be renovated and strengthened. A great International Exhibition, if it is on a sufficiently large and imaginative scale, could contribute to that end very considerably. It might be that if the Exhibition were held in London in 1951, the United Nations itself might hold its Assembly in this city in that year. That is only thrown out as a possibility.

On the other side of the matter—the commercial and industrial aspect—there undoubtedly, I suggest, such an Exhibition would serve a most useful purpose to the world at large, and to this country in particular, if it were the host to visitors

from all over the world. The weak spot in our national economy at this time is well known to be the difficulty of foreign exchange. The hard task set to us is to find the means of paying for the imports which are essential if our people are to maintain a high standard of life. One means, amongst others, to overcome that difficulty is to encourage what is called tourism—to encourage foreign visitors to come in very large numbers, because they bring with them an expenditure of foreign moneys, and particularly of dollars, which would be invaluable in view of the fact that we have lost, owing to war sacrifices, so large a part of our foreign investments. We have had to dispose of these, thereby losing one of our principal sources of income from abroad. An Exhibition would bring here many millions of people, and their expenditure would run into very many millions of pounds. In addition to that, it might stimulate the work of the Travel Association and other means that are being adopted now to encourage tourism in this country as a permanent feature of our national life. I heard the spokesman of the Government two days ago in the House of Lords, when discussing this question of foreign exchange, mention—not in connection with the Exhibition, but as a factor that was relevant—that the year 1951 would be the year in which the Treasury would be specially hard-pressed because it would, in that year, have to take over the obligations which are now met by the American and Canadian loans. That assistance comes to an end in that year, and if at that very time we had an influx of many millions of dollars into this country, drawn here by the magnitude of the Exhibition, and an influx of the currency of other foreign countries, it would be a relief to our economic situation.

Furthermore, an Exhibition would give a stimulus to international trade generally and to our own trade in particular. I know that some industrial authorities consider that such exhibitions are not of very great direct value to the manufacturer and the merchant. Opinions may differ as to that, but indirectly, and in the long run, there can be no doubt that an international Exhibition of that kind, in which the various nations meet one another in friendly competition in the sphere of commerce, must be of great economic advantage.

Therefore, for all those reasons, we suggest that the objects to be attained are so large and so important that it is worth while making some minor sacrifices and putting up with some inconveniences in order to achieve those purposes.

The difficulties that face us in relation to this Exhibition concern the site, the supply of labour and materials, and accommodation and transport. Exactly the same situation arose in the years immediately preceding 1851. If you read the records of that time, you will learn that the promoters of that Exhibition were faced by strong opposition and that innumerable fears and alarms were raised as to the effect of it. It was only through the persistence of this Society—the Society of Arts—and the encouragement of the Prince Consort that the matter was carried through in the face of all those difficulties. I seem to hear at this moment some echoes of the doubts and difficulties and fears that were expressed in the years 1849 and 1850. We have no Prince Consort now to give that driving force, but public opinion could supply it, and if public opinion is aroused, then the scheme will be carried through in its entirety.

Three questions are put before this Conference to-day. First, whether it is desirable to hold an International Exhibition. Secondly, where it shall be held. Thirdly, when it should be held. The questions are the principle, the site and the date; all three are connected together. Anyone speaking to the first question—whether it is desirable to hold it or not—cannot avoid also considering whether any suitable site would be available, and whether difficulties of labour and transport would make 1951 too early. I imagine, therefore, my Lord President, that you would not call to order anyone who, speaking on the principle, also found it necessary to touch upon the questions of site and date. Therefore, it appears to me—and possibly the Conference will agree—that the whole matter must be considered as one, because unless we see some hope of solving the problems of site and date it is useless to declare ourselves quite vaguely in favour of the general principle. On the other hand, I doubt whether a Conference such as this would desire to consider in detail questions of alternative sites. Some may advocate the Crystal Palace, some may think it would be better to be some distance outside the centre of London, and some may think that Hyde Park—or Hyde Park and Kensington Gardens together—would be desirable. On those points we should be glad to have expressions of view from those who take part in the discussion, but I should myself be inclined to doubt whether it would be desirable for this Conference to endeavour to state quite definitely that the Exhibition should be here or should be there. That would be a matter for consideration by some properly appointed authority, nominated by the Government, which would go into all the technical details of transport, accommodation, traffic, and so forth, that would arise before one site was decided upon as against another. but perhaps it might be useful if speakers would kindly express their views on the general question whether, in the public interest, the people of London should be asked to surrender, for perhaps a couple of years, the use of Hyde Park, or even the use of Hyde Park and Kensington Gardens. We have been told on high authority that the proposal has hitherto been rejected by the Government because they are convinced that public opinion in London would not support the allocation of the Park for that purpose for so long a time. That is a matter to be decided, I think, by the voice of the people and by the voice of representative persons, such as those who are assembled here to-day. The people should decide whether the inconvenience and sacrifice is worth while or not, in view of the objects to be achieved. If Hyde Park is vetoed, then you have to look for somewhere else. The Crystal Palace site offers about 200 acres, and whether that would be sufficient is a matter for you to consider. If neither of those sites is available, then it would fall to be decided whether it would be desirable to go outside London to some other place, as the Wembley Exhibition did, having regard to the difficulties of transport to and fro which would be imposed upon the visitors.

As to the date, there, again, we may express hopes, but I do not know that this Conference, as a Conference, could either declare or deny that 1951 would be a practicable date. Views can be expressed, and particularly with regard to materials. There are some experts here who could tell us whether the traditional building materials and the timber which is in short supply at present are essential in large quantities for an Exhibition of this kind, or whether we might turn in an imaginative

spirit to new building materials, which might be very glad to advertise themselves in providing the wherewithal for buildings of this character.

Those are the problems which are placed before you. You will remember that it is over 70 years since any International Exhibition was held in London. Therefore, our claim to hold one now is a very strong one. Furthermore, we may believe that the efforts of Great Britain in the war, and the sufferings and sacrifices of London in particular, give to this country and to this city a strong claim to international support for an enterprise of this character.

Briefly, the short point before us is whether we ought to be ready to surrender to the difficulties or whether we ought to strive to overcome them.

THE CHAIRMAN: I mentioned just now that the Society's sub-committee has kept closely in touch with the Government in connection with the action which it has been taking. Before you proceed further with the expression of your views, I should like you to know that copies of the documents which were forwarded to you were sent to Sir Stafford Cripps, whose Secretary wrote:—

> "The President will be expecting a report of the views expressed at this meeting as soon as you are in a position to make them known. He is grateful to you for inviting him to the Conference, but I am afraid that because of heavy pressure of work he will not be able to attend".

I now call upon Mr. Goodale, who was a member of the Ramsden Committee and who has considered to some considerable extent the question of the 1951 Exhibition.

Mr. E. W. GOODALE, C.B.E., M.C.: I think it would not be inappropriate if I read to you the relevant passages of the Ramsden Committee Report dealing with this matter.

The Committee was appointed by the Secretary for Overseas Trade in the Autumn of 1945, and the third of its terms of reference was: "To consider the desirability of organising an Exhibition in London in 1951". That matter was very carefully considered by the members of the Committee, who agreed unanimously to make this report:—

> "We are strongly of opinion that a Universal International Exhibition should be held in London at the earliest practicable date to demonstrate to the world the recovery of the United Kingdom from the effects of the war in the moral, cultural, spiritual and material fields. We feel that such an exhibition could be a great demonstration of international progress, and particularly of the standing of the British Empire. It would be a means of promoting better understanding between the nations as a result of visits of Empire and foreign nationals in large numbers.
>
> "We suggest that 1951 would be a suitable date since it will be the centenary of the great International Exhibition of 1851, but, if this is not practicable, we consider that the exhibition should not be long delayed after that date, if it is to serve its full purpose as a demonstration of our recovery from the effects of the war.
>
> "Since the International Exhibition of 1851 achieved an overwhelming

success, any celebration of its centenary must be staged on a scale to ensure a repetition of that success. It should surpass the New York World's Fair of 1939 in scale and technical achievement and the Paris Exhibition of 1937 in æsthetic excellence and personal appeal.

"We consider it essential that the site for such an exhibition should be in central London. The success of the various exhibitions in Paris has been mainly due to the fact that they were staged in the centre of the city and full use made of the banks of the Seine. An exhibition thus sited becomes part of the life of the city.

"While it is not possible to specify a particular site for a 1951 International Exhibition in London (though the first choice from a purely exhibition point of view, would fall on using Hyde Park), parts of the blitzed areas in central London and the neighbourhood of Waterloo Station, including the south bank of the Thames, are possible alternatives. These cannot rival Hyde Park as a site, nor do they offer an adequate continuous area.

"It is important, in view of our recommendations with regard to the International Exhibitions Convention, to make an announcement as soon as possible of our intention to organise such an event in 1951.

"We have made our recommendations purely on the merits and advantages of an exhibition. It is realised that any such exhibition must result in considerable expenditure and the diversion of labour and materials at the expense of other urgent forms of post-war reconstruction. To justify the heavy expenditure of money and the large allocation of labour necessary to make an international exhibition a success, it is essential that in the meanwhile there must have been adequate progress made in the provision of dwelling-houses, schools and other public institutions already promised, and, in addition, sufficient industrial buildings of all classes provided to enable industry to function efficiently.

"We therefore recommend that:—

"(*a*) Despite the difficulties which must be surmounted, a Universal International Exhibition should be held in London in 1951, or at as early a date thereafter as may be practicable, bearing in mind that to serve its full purpose, such a demonstration of our recovery from the effects of the war in the moral, cultural, spiritual and material fields cannot be long delayed;

"(*b*) If such an exhibition is organised it must be a dynamic success, and no money or effort should be spared to guarantee that it will surpass any previous international event of the same character;

"(*c*) To achieve the desired ends, it is essential that the exhibition should be sited in central London".

There was then a further recommendation that if it was not possible to stage an International Exhibition, it would not be proper to stage merely an Empire Exhibition.

That, I think, summarises the views of the Ramsden Committee in better words

than I could myself compose, and I will, therefore, present that to the Conference.

The CHAIRMAN then invited other delegates to express their views on those three points—the principle of holding an exhibition, the site favoured, and the date.

SIR ROBERT ROBERTSON, K.B.E., F.R.S. (Royal Society) said that the Royal Society supported the idea of an exhibition, and the use of Hyde Park as a site, and agreed as to the advantage of making it mark the centenary.

Mrs. PATRICK NESS (National Council of Women), on behalf of her organisation, said that they would do all in their power to support such an exhibition. Experience they had gained at the Glasgow Empire Exhibition of 1936, might be of value, should there be a Women's Pavilion. She thought that every endeavour should be made to hold the exhibition, if at all possible, in 1951. The Chairman of her Council's Housing Committee had reassured her on the question of the availability of materials, holding that by 1951 new building materials, not in use just now, would relieve the situation.

As one of those who lived near Hyde Park, she thought that few people would not forgo the amenities of the Park for the required period if it were to benefit the country. The use of the Park, however, would be contingent on the solution of the traffic problem.

Major A. A. LONGDEN (Art Director, the British Council), gave an assurance on behalf of the British Council that it would support the project with every means at its disposal. It could do much to publicise such an exhibition overseas. He added that the "Britain Can Make It" Exhibition had demonstrated that we had in this country plenty of experts in presentation.

Mr. H. S. HYDES (General Manager of the Travel Association) recalled that the Travel Association had already indicated last March its willingness to support a 1951 exhibition, because it would attract visitors to the British Isles. The most careful consideration should, however, be given to the question of accommodating these visitors, and that the provision of adequate hotel facilities should be made a definite part of the exhibition arrangements. The possibility of continual traffic congestion consequent on the use of Hyde Park, made the Association feel that some relatively convenient site, such as the Crystal Palace, would be preferable. The organiser of an exhibition could count upon the fullest help in overseas publicity from the Travel Association.

Col. The Hon. G. K. MASON (Metropolitan Public Gardens Association) in expressing his views, remarked that it might do no harm to introduce a note of controversy. He believed that a series of small exhibitions devoted to specialised trades, such as motor cars, light engineering, textiles, etc., would be of greater commercial benefit and be more effective in bringing together representatives of these trades, than a single enormous exhibition. Exhibitions always involved the promoters in loss, which should be compensated for by the general good effect on trade. In this instance, he did not think the effect on trade would repay the expense in time and labour.

Lord Samuel had stressed the cultural value and the aid to world peace of such an exhibition. For his part he believed that ninety per cent. of people treat such exhibitions as a sort of fun fair, rather than as an event organised for cultural purposes. As to the effect on world peace, we could not forget the fact that the Prince Consort's Exhibition was followed by the first major war since Waterloo.

He had doubts, therefore, as to the value of holding the exhibition at all, and was even more definite in his opinion as to the date. In Fulham, 7,000 families were living in single rooms, and no doubt similar conditions existed in other metropolitan boroughs, and in many provincial cities, while thousands of firms were strewn up and down the country, unable to regain accommodation in the city of London. He did not believe that this position would be remedied by 1951, and, until it was, he was dead against

allocating thousands of men and vast quantities of material to the building of exhibitions; for those reasons he was dead against the exhibition being held. Also he was absolutely against the use of Hyde Park, and no one else he had asked had been in favour of it. Londoners had had a great deal to put up with in the last six years. Their "lungs" had been denied them because of anti-aircraft guns, balloons, etc. They had just got them back, and now were being asked to give up their largest and best for three years.

Mr. HUGH WALKER (Assistant Secretary, United Nations Association) said that his Association would be very gratified to hear Lord Samuel's remarks on the effect of such an exhibition on international relations. They would like to participate in the exhibition, in the specific direction of enlightening the British people on the ways of life of other peoples, and on the work of the United Nations Organisation. His executive did not feel technically equipped to contribute any views on date and site, but its members were of the opinion that 1951 was too early. They also sympathised with the arguments from official quarters against the use of Hyde Park, and suggested consideration of an Outer London site.

THE CHAIRMAN then called upon Mr. Alfred Bossom to speak, as a Member of Parliament.

Mr. A. C. BOSSOM, F.R.I.B.A., M.P., said he was delighted to have heard the objections, for he believed they were the only ones that could be raised. First of all, there was the question whether 1951 was a proper date in view of housing shortages, etc. We had the assurance of Mr. Aneurin Bevan that we were going to have 300,000 houses finished by the end of 1947. Of course, we would not finish all our housing programme for twenty years; but whoever was in power, the building industry was capable of supplying our immediate needs before 1951. We must not use housing as an excuse for not going ahead.

When, he asked, were we going to throw off this lethargy from which we were suffering? We all had a feeling of being held down, a sense of frustration, a feeling that "We can't do it". We would have to shake off this feeling if we were ever again to be one of the leading nations of the world. We must overcome difficulties. Our attitude must be "We *can* do it". It would not be done easily, but it could be, and for the nation's well-being, it must be done. We could produce the labour. Many countries would send their own workers, and for the rest we could produce the men, and the women. The use of Hyde Park might raise objections, but we must not take up too negative an attitude. As to materials, there are many new ones, and we had read that very morning that we should get all the timber we needed from Canada and America this year. Let us fix on the date, 1951, and the place, say Hyde Park, and set a definite target. He endorsed all that Lord Samuel had said. We should make this a great cultural exhibition and lift it above the commonplace in every way. Let the country know that there was a group of responsible people who believed this thing could be done, and we should go a long way to revive that confidence in our power of achievement, which had meant so much to us in the past.

The Right Hon. Lord ABERCONWAY, C.B.E. (President of the Royal Horticultural Society), said that his Council were convinced that the plans put forward by the Royal Society of Arts were sound, and that we should try to surmount the difficulties. In the particular field of a possible horticultural section, his Society would co-operate with every means in their power.

Miss J. TYRWHITT summed up the views of the Association for Planning and Regional Reconstruction. The Association welcomed the proposal of an exhibition; agreed that it should be held in 1951; but held that though it should be in central London it should *not* be in Hyde Park. It would be hypocrisy to call for decentralisation and open spaces, and simultaneously to appropriate Hyde Park. The south bank of the Thames between

Westminster Bridge and Waterloo Bridge was almost completely blitzed. It was priority No. 1 on the L.C.C.'s plans. The buildings there could be permanent and the labour would not be wasted. The holding of the exhibition there might lead to the development of the south bank, as the 1851 Exhibition developed Kensington.

Mr. JACOBS, Secretary of the London Trades Council, gave the views of his Executive. They opposed the scheme as an unwarranted waste of men and materials at the present time. Hundreds of thousands were homeless, and whatever the Press said, materials were short. Hundreds of thousands of workpeople, and some of the best craftsmen the Unions could supply, would be required. They could not be spared from building the houses of ordinary people. The exhibition would take much longer than a year to build. The experience of the New York and Paris Exhibitions proved that. It would make us more, not less lethargic, to realise that men and materials were being used to build, not homes, but an exhibition. Again, London had insufficient hotels; and they were not in favour of building hotels instead of homes for the people. At any other time his Council would have supported an exhibition, but, at the moment, they thought the project ill-advised, and regretted to say that if a decision were taken to go on with it, they would actively oppose it.

Mr. C. H. GILKES (Headmasters' Conference) wished to put forward the case of education. His own school had suffered war damage, and he had been told that he could not even apply to rebuild for another five years. It was nonsense to suggest that the situation in 1951, in the educational world at least, would not be completely disastrous. This criticism, of course, applied to the date, and not the idea, of the exhibition.

Mr. W. R. DAVIDGE (Past President, Town Planning Institute), agreed that we needed an uplift from our present state of dismal frustration. He doubted if the exhibition would be fully international, but would rather be an Exhibition of the Allied Countries. He was against Hyde Park as a site; there were plenty of others such as the Crystal Palace or Duke's Meadows. We had hundreds of landing craft; why not put them two or three deep along the banks of the Thames and erect our exhibition on them?

Major C. B. J. ATHOE (Secretary, The Incorporated Association of Architects and Surveyors), read a message from his President, who was detained by illness. This expressed the view that the building trade "might as well put the shutters up" if it could not commence operations on a large scale in 1950.

The obvious site for an exhibition like this was central London, and the ideal site was Hyde Park. The park had been given to the people of this country, and if a referendum were taken, there is little doubt they would favour it as a site. It was ideally situated for travel facilities. When the Great Exhibition was held, there were many other open spaces in London, but these had all since been built over. The experiment of moving the Great Exhibition to Sydenham had been a failure. It proved that an exhibition of this kind must be in central London. Exhibitions in other countries, such as the Paris Exhibition, were held in their metropolis. Moreover, the park had already the services—main drainage, water, electricity, etc.—which were needed. To the President's observations Major Athoe added that it would be ridiculous to take up other sites which could be used for building purposes; and speaking as an architect, and a naval architect, the idea of a Noah's Ark along the Thames was unthinkable and ridiculous. Quite different types of craftsmen, too, would be required for exhibition and house-building work; we should find them if we looked for them.

Mr. T. A. FINNEMORE (Central Institute of Art and Design), conveyed the congratulations of his Council to the Royal Society of Arts for taking the initiative in this matter. They were interested in the idea of an exhibition which stressed cultural achievements. They did not feel competent to criticise its date, but would like to see it held as soon as possible. Neither would they take it on themselves to advise on the site, but they tended to favour the south bank scheme, especially as buildings there could be left standing.

They had considered Regent's Park for the same reason, as there were bombed sites round its fringe on which permanent buildings could be built.

Mr. G. EDWARDS (Secretary, the Royal Society of Medicine), expressed the feeling of his Council that if any exhibition were attempted, it must be sure of a resounding success. They would gladly support any expert body who could say that this could be done, say, in 1951. For the reasons given by other speakers, they disapproved of Hyde Park as a site. Speaking personally, he approved of Miss Tyrwhitt's suggestion of the south bank, comparing it with the beautiful placing of the exhibition buildings beside the Seine in Paris.

Sir ALFRED CHATTERTON, C.I.E. (East India Association), reported that his Council had come to the conclusion that 1951 was too soon a date. They favoured the holding of an exhibition at a later date, when preparation could be more adequate. They were not in favour of holding it in Hyde Park, nor at the Crystal Palace by reason of the difficulty of access to it.

The Right Hon. LORD SEMPILL, A.F.C. (President, the Design and Industries Association and the Institute of the Motor Industry), supported enthusiastically the idea of a Centenary Exhibition as outlined by the Chairman and by Lord Samuel.

Mr. H. G. DOWLING (Incorporated Institute of British Decorators), speaking on behalf of his Institute, expressed wholehearted support of Mr. Bossom's sentiments. The Chicago World's Fair Exhibition had been held in 1933, in the midst of the great depression in America. He agreed with the advantage of the south bank scheme, in making it possible to erect permanent buildings if desired.

Dr. J. S. BAKER (Institution of Naval Architects), said that he was authorised to state that the Institution of Naval Architects were sympathetic towards the idea, but did not feel qualified to express a technical opinion on the site or date. Speaking personally, he would like to point out that, so far from all exhibitions being run at a loss, the 1851 Exhibition had been a great financial success, and many young men owed their technical education to bursaries and scholarships endowed with the profits.

Mr. H. J. T. ELLINGHAM (Royal Institute of Chemistry), on behalf of his Council, supported the idea of an exhibition at the earliest possible date. As to the site, Hyde Park had the advantage of several large buildings—museums, the Albert Hall, etc.—suitable for exhibition purposes, grouped round it, as a result of the 1851 Exhibition. He reminded critics of the south bank site, however, that part of Waterloo Station was actually north of Hyde Park Corner; the site was therefore much more central than many supposed.

Mr. MILNER GRAY (Society of Industrial Artists and late Head of Exhibition Branch, Ministry of Information), speaking as President of the Society of Industrial Artists, pointed out the increasing extent of exhibitions, from the twenty-one acres of the 1851 Exhibition to the 1,210 acres of the New York Exhibition. We should call a halt to this trend and concentrate on the quality of exhibits, and the imagination exercised in their display.

Mr. HAROLD BAILEY (General Assembly of Unitarian and Free Churches), recalled the success of the 1851 Exhibition, the splendid work it did, and the good effects which remained. He hoped we could look forward to a similar success in 1951.

The Dowager LADY SWAYTHLING (President of the Electrical Association for Women), believed that traffic congestion round Hyde Park would present an insoluble problem. She, therefore, was attracted by the south bank scheme with its opportunity for permanent buildings on a river frontage, and instanced how Rio de Janeiro had been permanently enriched by such an exhibition.

Mr. FRANK E. BERESFORD (Anglo-Netherlands Society), expressed the belief that, judged by the effects of the 1851 Exhibition and the New York World's Fair, the exhibition would be a great influence for good.

Mr. G. E. HAYNES (Secretary, National Council of Social Service), as one in touch with a large number of young people's organisations, attempted to sum up the feelings of young people. He believed that nowadays they were realists, and given the choice would prefer schools and houses to an exhibition. At the same time, he felt that they were experiencing, more acutely than older people, a sense of frustration, and would be glad to take any opportunity of co-operating with the promoters of the exhibition. He thought the weighing up of the technical pros and cons should be taken further by experts.

Mr. R. J. H. GROSE (British Employers' Federation), said he thought that the youth of this country, having helped to win the war, needed some other constructive objective put before them.

Mr. R. W. J. KEEBLE (National Council, Young Men's Christian Association), said that he was one of the generation which has come back from the war to find that he might expect a house in three-and-a-half years' time. Partly for that reason he had no family. Most of his hearers had homes and families; he asked them to deliberate carefully before they attempted to influence public opinion on the subject of the exhibition. He did not think that an exhibition would cure the lethargy and malady from which the country was suffering. As a member of a Christian youth organisation he could say something on that subject, but this was not the appropriate occasion.

Miss CAROLINE HASLETT, C.B.E., speaking apart from the several official capacities in which she might speak (including that of a Vice-President of the Royal Society of Arts), pointed out that the President of the Board of Trade had recently appointed a British Tourist and Holidays Board, on which both the T.U.C. and the Employers' Federation were represented. Presumably the country was committed to the policy of attracting visitors, and the Government must know that that entailed improved and increased accommodation for them. She supported Miss Tyrwhitt's south bank scheme, and knew that she would not advance it unless her organisation had given it much thought.

Mr. Jacobs had made a real point on the question of labour and supplies, and we ought not to divert them from housing and the like; but might we not regain the Mulberry spirit and do something unusual for this special occasion? Her post* suggested to her that there were many women who had engineering and other training during the war, and would like to use it again for the benefit of their country. Could not we again mobilise that labour force? At the Ministry of Labour during the war we were often faced with the question of where to get more labour. By training, selection, and the use of new materials, we had always overcome the difficulties.

Mr. E. MUNRO RUNTZ (Treasurer of the Royal Society of Arts), gave as his private opinion that it was most unlikely that an international exhibition could take place in 1951. It would probably take three years to plan, two to build, and two to pull down.

LADY ALLEN OF HURTWOOD (Institute of Landscape Architects), said we should create and not destroy. An exhibition in Hyde Park would destroy something of beauty; on the south bank it could wipe out the ugliness there and replace it by something of lasting value. It would also be a retrograde step to take away the Park from young people when there was so much juvenile delinquency and so many street accidents, due in part, to lack of open spaces.

THE CHAIRMAN: I would like to add one word. Sitting here, I have seen in my mind's eye the men who, a century ago, were gathered here considering the establish-

*Miss Haslett is Director of the Electrical Association for Women.

ment of an exhibition.They encountered difficulties—very great difficulties. If you read the papers of those days, you will see it was thought to be impossible to do it. They went out and held public meetings and got the people interested. In the end the exhibition was held, and its effects are still being felt. It was not only a great success, but one of the most potent influences this country had experienced. It was the first great International Exhibition, and we are still feeling its effects to-day. I have been brought up to believe that the Englishman—I use the word in its generic sense—is not easily deterred. Are the men and women who are living to-day in this old city less worthy of confidence and less equipped to discharge a great duty than the men who sat here a hundred years ago? Have we deteriorated? Some people say we have, but all you have got to do is to look about you and see what happened in the last seven years, and then you must change your mind. Can we successfully cope with the difficulties? No difficulty which has been stated here to-day is new to those who have read what took place a century ago. Whatever we may do, let us not admit defeat before we start.

I will ask Lord Samuel to close the discussion.

VISCOUNT SAMUEL: I will be very brief because I see that, probably for gastronomic reasons, a large proportion of the audience has already left, and those of you who remain are, no doubt, impatient to do the same.

This Conference has undoubtedly served its purpose, not least in eliciting various opinions. It has not been a cut-and-dried conference called to promote a particular object, but rather one to elicit the views of those who, in a representative character, are entitled to express them.

The most formidable opposition came from Mr. Jacobs, on behalf of the London Trades Council. He opposed the whole project and said his organisation would conceive it to be their duty to oppose it themselves. He, I notice, continually referred to conditions at this time, to what appeared in this morning's newspapers, and to the pressure on materials and labour at this time. He most pessimistically assumed that things would be the same in 1950. We are now in February, 1947. What is happening at this moment may not be at all an indication of what the situation will be in three years' time, and, indeed, we should be taking an exceedingly pessimistic view if we thought the Government and the nation together would not have emerged by then from the most formidable difficulties which confront them now, in the way of lack of labour and materials. He spoke of this work needing hundreds of thousands of workmen—to erect this exhibition, and to take it down. That, surely, is a wild exaggeration, particularly if you take into account the fact that many of the nations who will be invited to participate will also be invited to send their own materials, which they are usually anxious to do for advertisement purposes, and also to send their own labour, which they may be willing to do. If half the exhibition is international and half is British, half our difficulties will thereby be disposed of. I would observe also that, as I said in my opening remarks, the traditional building materials may, by that time, be to a large extent superseded. I noticed that Mr. Bossom and the representative of the Institute of Decorators (who are in close touch with the building industry), said that in their opinion there

would be no difficulty whatever in fulfilling the demands which would be made upon the industry, even in the time that remains to us between now and 1951.

The difficulty, I agree, is in the provision of hotel accommodation, but it may be that a considerable number of boarding houses will be opened in London. The neighbourhood on the north side of Hyde Park—where I live—already consists largely of old family houses which have been turned into boarding houses and private hotels. Possibly a large number of these could be opened, even temporarily, by hotel companies for this particular period.

There was one specific point raised to which I should like to make reference. One speaker suggested that this ought to be not a world exhibition but one limited to the Allied countries. I earnestly hope that that proposal will not be considered for a moment. The world would be in a very bad way if, six years after the end of the Great War, it was still divided into Allied and non-Allied countries. It is vital to the welfare of mankind that the ex-enemy countries should return to the comity of nations, and by that time, it is to be hoped, all or most of them will be members of the United Nations. It is unquestionable that the Exhibition should be as universal as it may be made.

As to the site, on which different views have been expressed, I myself have lived practically all my life within five minutes of Hyde Park and Kensington Gardens, and I do so now, but I should not object in the slightest degree to the whole of that area—both parks—being sacrificed for a comparatively short period of time, even three years if necessary, to serve an object of so important a character as this, the influence of which is likely to extend over so long a time. As for the Park being destroyed and its beauty ruined, there is not the slightest danger of that, any more than there was in 1851. It would be restored, and perhaps improved after the Exhibition was over. At the same time, however, I am not so worried about Hyde Park as to say it must be there or nowhere; I am only anxious to get the best site that can be obtained, taking all considerations into account. The south bank of the Thames has many attractive features, but we have not been told what area would be available. I have seen no reliable estimate of the area that would be available, and that is a point of considerable importance.

I agree with the view which has been expressed that we need not seek to emulate the New York Exhibition, which covered about two square miles. It would be too fatiguing for the visitors, and it is not necessary. One idea passed through my mind as speeches were made advocating the south bank and opposing the park. I do not know whether it is practicable, and it is certainly very much a second best. It is that the Exhibition might conceivably be divided into two sections, not too far apart, but not necessarily adjoining. No person could visit the whole of an exhibition like this in one day. I have visited a number of them—Chicago, Paris, and many others—and I know the fatigue that results from trying to see too much at once. Therefore, it might not make it impossible for the visitors if the Exhibition were in two places, and if it was necessary for them to make at least two visits to see it. Possibly the south bank might be used and the Crystal Palace, or any other combination. That would probably be better than taking the Exhibition right outside London, as some have suggested.

The Royal Society of Arts has not drafted any resolutions to put before this Conference. This, as I say, was not intended to be a cut-and-dried conference to adopt any particular scheme. The Chairman does not suggest that we should vote upon any resolutions now. In the first place, a decision upon the site and upon the date must involve all kinds of considerations which would have to be balanced one against the other. It would need technical examination and evidence from various quarters. This Conference would not regard itself as competent to decide here and now either for 1951 or for a postponement, or for Hyde Park, Crystal Palace, the south bank, or any other site. Therefore, we do not ask you to vote upon these matters. The Conference has served its purpose by eliciting so many opinions in such an admirable fashion and having such high representative quality. There is a further reason why we should not vote, and it is that most of us—and I mean by "us" those who were here at the beginning—have already left the room and it would only be a very small proportion who would be in a position now to express their opinions.

THE CHAIRMAN announced, with regret, the death of Miss Ellen Wilkinson, the Minister of Education, and the proceedings then terminated.

A verbatim report of the Conference was sent to the President of the Board of Trade, accompanied by the following letter from Lord Samuel, acting on behalf of the President:—

Royal Society of Arts,

February 14th, 1947.

My dear President of the Board of Trade,

Proposed International Exhibition

Our President, Lord Bennett, acting under doctors' orders, is staying for some weeks in the country, and he has asked me, as Chairman of the small Committee which visited you in December on behalf of the Council of the Royal Society of Arts, to act for him in matters relating to the proposed Exhibition.

In accordance, therefore, with your private secretary's letter of January 16th to Lord Bennett, I am forwarding to you herewith a copy of the verbatim report of the Conference which was held here on February 6th, together with a list of the organisations which accepted an invitation to attend it. The excellent attendance of representatives at this Conference was an immediate demonstration of public interest in this matter, and it was clear, both from the actual speeches made at the Conference (as you will see from the report) and also from the general feeling of the meeting, that the great majority of opinion is strongly in favour of holding an international exhibition at the earliest practicable date.

There was some difference of view, however, as to what that date should be and as to the most suitable site, and the Council of the Society, at their meeting

last Monday, asked me to tell you, when forwarding this report, that they very much hope that you might be able to spare the time to receive again our small Committee, so that they might discuss these points with you, and also inform you of the steps which the Society feels should now be taken.

We make this request, fortified in our assurance that on the basic issue the public is well-nigh unanimously for the Exhibition.

If, as I very much hope, you are able in spite of your many commitments to grant this interview, we should propose to send you beforehand a summary of the points we wish to submit.

Yours sincerely,

(Sgd.) SAMUEL.

The following reply was received from Sir Stafford Cripps:—

Board of Trade,
February 26th, 1947.

My dear Samuel,

Thank you for your letter of February 14th, enclosing the verbatim report of the Society's Conference on February 6th, about the International Exhibition proposed for 1951.

I find this very interesting and I am struck by the resemblance between the various opinions expressed and our own views some months back, before a detailed assessment of the implications of the proposal had been made with expert advice. This assessment proved most disappointing, and I fear that the Conference has done (and, indeed, could do) little to reassure me that the heavy demand upon construction labour could be undertaken without serious diversion from more immediate necessities. The larger proportion of this labour would be required not for construction on the site, but for the transport improvements essential to carry the heavy traffic anticipated. This factor would be little less important in the case of Hyde Park than for a suburban site, and we cannot foresee that the legal and physical problems could be overcome before 1951, even if labour were freely available.

I fear, therefore, that there is little possibility of the Society's faith in the project outweighing the facts which examination has brought to light. If, nevertheless, you feel that a discussion would help, Marquand will be very glad to see you.

Yours very sincerely,

(Sgd.) R. STAFFORD CRIPPS.

LIST OF ORGANISATIONS ATTENDING THE CONFERENCE

The following is a list of organisations and bodies whose representatives were present at the Conference:—

Institute of Actuaries.
Anglo-Belgian Union.
Anglo-Hellenic League.
Anglo-Netherlands Society.
Anglo-Swedish Society.
Incorporated Association of Architects and Surveyors.
Central Institute of Art and Design.

Association of Art Institutions.
Art Workers' Guild.
Royal Academy of Arts.
Arts Council of Great Britain.
Automobile Association.
Baptist Union
Boy Scouts Association.
British Association for the Advancement of Science.
Association of British Chambers of Commerce.
British and Central European Chamber of Commerce.
British Council.
Incorporated Institute of British Decorators.
British Empire League.
British Employers' Confederation.
Canadian Chamber of Commerce in Great Britain.
Archbishop of Canterbury.
Society of Chemical Industry.
Royal Institute of Chemistry.
Institution of Civil Engineers.
Chemical Society.
British Association for Commercial and Industrial Education.
Crystal Palace Trustees.
Society for Cultural Relations with the U.S.S.R.
Design and Industries Association.
East India Association.
Association of Education Officers.
Electrical Association for Women.
Institution of Electrical Engineers.
English Speaking Union.
Franco-British Society.
Free Church Federal Council.
Geological Society of London.
Girl Guides' Association.
Headmasters' Conference.
Association of Head Mistresses.
Housing Centre.
Hotels and Restaurants' Association of Great Britain.
Imperial Institute.
Society of Industrial Artists.
Council of Industrial Design.
Chartered Insurance Institute.
British Society for International Understanding.
Iron and Steel Institute.
Institute of Journalists.
Institute of Landscape Architects.
Library Association.
London Chamber of Commerce.
London Society.
London Trades Council.
Institution of Mechanical Engineers.
Royal Society of Medicine.
Metropolitan Public Gardens Association.
National Housing and Town Planning Council.
Institution of Naval Architects.
Over-Seas League.
Institute of Park Administration.
Royal Aeronautical Society.
Association for Planning and Regional Reconstruction.
Royal African Society.
Royal Asiatic Society.
Royal Automobile Club.
Faculty of Royal Designers for Industry.
Royal Empire Society.
Royal Geographical Society.
Royal Horticultural Society.
Royal India Society.
Royal Institution.
Royal Photographic Society.
Royal Sanitary Institute.
Royal Society.
Royal Society of Edinburgh.
Episcopal Church in Scotland.
Church of Scotland.
Chartered Institute of Secretaries.
National Council of Social Service.
Institution of Structural Engineers.
Royal Institution of Chartered Surveyors.
Association of Teachers in Technical Institutions.
Town Planning Institute.
National Chamber of Trade.
Trades Union Congress.
Institute of Transport.
Travel Association.
General Assembly of Unitarian and Free Christian Churches.
United Nations Association.
The Archbishop of Westminster.
National Council of Women of Great Britain.
National Federation of Women's Institutes
Women's Voluntary Services.
Workers' Travel Association.
Young Men's Christian Association.
Young Women's Christian Association.

ECONOMIC RECONSTRUCTION

(II) A SCIENTIFIC APPROACH TO LABOUR PROBLEMS

By WALTER C. PUCKEY, *Director and General Works Manager, Messrs. Hoover, Ltd.*

Ninth Ordinary Meeting, Wednesday, January 29th, 1947

The Right Hon. LORD CITRINE, P.C., K.B.E., *in the Chair*

THE CHAIRMAN: This series of lectures, which is being given here, concerns a series of problems which I am sure is a matter of deep concern to every interested citizen. I have not had the pleasure of hearing the earlier lectures in the series, but I have had the opportunity of perusing the paper which our lecturer for this evening, Mr. Puckey, is to present to you. It is a very thoughtful paper and raises many issues which are in my experience all too commonly absent from the consideration of persons who have to deal with this range of questions. I do not propose to make any comments or to enter the ground which the lecturer will cover. I would merely like to say that I think probably the greatest problem connected with the whole of this subject is to plan a scientific, efficient administration of industry with the fullest consideration for the personnel in the industry. I think it is a mistake to assume that when one talks about scientific problems in relation to labour one is dealing with something other than human problems and that the two things are separate. In point of fact they are very closely related indeed. I do not care what the form of economic organisation is with which we are dealing; or whether it is viewed from the point of view of a national economy or just that of an individual company or firm; finally the problem is going to be how to produce happy men and women whose creative instincts can be given full play in the work in which they are engaged.

That is our main problem and I am sure that this lecture will set you thinking about that problem. Our lecturer is well qualified to deal with this subject. You will see that he is director and also general works manager of Messrs. Hoover, employing some 6,000 people, men and women in approximately equal numbers at the moment. He has had a unique opportunity at first hand of gaining experience of how to handle those people and gauge their desires and aspirations and how these can best be coupled up with their work.

The following paper was then read:

The scientific approach assumes an objective outlook which should largely be divorced from the personality and background of the investigator. When dealing with human, as against material problems, however, it has always seemed to me desirable to know more about the person putting forward his views, as in human relations those with theories must at all times, however awkward it may occasionally be, equate their own theories to their own practices.

You should, therefore, know that I speak to you as one whose background has been largely engineering, from apprenticeship to director's office; and as one who, from this practical background has learned to submit every theory to the question "Will it work?", every practice to the possible development of a theory. Such a background of practical experience tends to classify "labour" as the factory worker only. May I also include other grades of people, such as white-collar workers, technicians, supervisors, managers, and directors, in fact, all who work for a living? My examples come from whatever source my own experience has covered.

THE SCIENTIFIC APPROACH

There are many sciences, but the term "scientific approach" may be applied to any activity and means to me:

(*a*) A clear statement of the problem.
(*b*) A systematic analysis of it.
(*c*) Utilization of appropriate external knowledge.
(*d*) A clear statement of the possible solution.
(*e*) Acceptance of responsibility for bringing these proposals to fruition.

Now this definition may appear to you to be not only the approach, but the end also, and involves a *dynamic* conception carrying on towards practical realization rather than remaining on the plane of theoretical reasoning. My background and present job as a working executive may give sufficient reason for this emphasis on conclusion as an essential end to investigation, coupled with the growing realization that to-day an increasing number of people have theories, but fewer than ever seem able also to make them work!

DIFFERENCES IN THE SCIENTIFIC APPROACH TO HUMAN AND MATERIAL PROBLEMS

Quite obviously there *are* differences in the scientific approach to labour and human problems, and to material ones; one has only to dwell on the amount of scientific attention paid to the relationship of one atom to another, one mechanical part to another, as compared with similar studies into the relationship of man to man, to realise the relative lack of attention paid to human relationships. One might argue that religion and politics have for centuries provided such studies, but these have been more concerned with the relationship of man to his God or party rather than with his fellow-creatures direct; and, with all due respect, they have throughout the ages engendered more subjective passion than objective reasoning. Both secular and political authorities have tended more towards establishing and maintaining the party line than contributing much to the principles of man's relationship to man. The fighting forces and industry have done more to establish a foundation, and it is in and through industry that I believe the scientific approach to most human problems will be concentrated largely in the near future.

Material sciences themselves have become greatly complicated, and we see daily new ways being found of combining the elements, physically and chemically; new techniques being evolved; new specialists being trained to deal with them; and as Linklater says, the only one not entering for the race of progress is man himself. We are more expert at disintegration than integration. New subjects such as food technology, gas turbines, jet propulsion, supersonic air flow, nuclear chemistry have been introduced. In this country new study specialisations are being introduced into every material field. By comparison the study of "man to man" is a mere academic diversion, with little realization that our increasing specialisation on material activities need even greater activities in the scientific approach to co-ordination and co-operation, so that what is split asunder to promote specialisation may be put together again to form society at large.

Now there are many who say that things of the soul—and that, I suppose is what distinguishes man from other things—are not susceptible to scientific study, that

"human nature" has not and will not change. History certainly gives plenty of evidence in favour of this, as far as basic characteristics are concerned, and there was probably little difference between the courage of David confronting Goliath and a bomber pilot confronting Berlin. Such characteristics as jealousy, fear, initiative, intelligence, have probably not altered much through the centuries, but cannot we say the same of hydrogen, oxygen, the sun's rays, coal and other natural things? Yet, by constant labour, these natural things are now isolated more effectively, combined differently, used to greater advantage in order to give us added material benefit, and occasionally, as in recent years, discomfort. Cannot we therefore envisage a possibility of "human nature"—that combination of many human characteristics—having its "combination" altered to provide a key to a better society? Cannot we at least envisage a significant betterment in the *combination* of "human natures"? If we are prepared to make the same scientific approach to these two possibilities as we have to material things, who knows what may emerge? I will sketch all too briefly some of to-day's labour problems and attempt to show whether a more scientific approach to them would provide a solution. Possibly we can get together again in about fifty years' time in order to record progress!

(A) Statement of the Problem

What is the labour problem? Perhaps the real problem to-day is in deciding the priority of the many problems. Is it food—queues—women who are emancipated in everything except equal pay—or men who are coming to realise that in many cases they are doing women's work? Is it a problem of managers or workers—under-employment in South Wales or over-employment in London—nationalisation or free enterprise—coal or electric motors—exports or imports?

Attempting to simplify these difficulties, many have decided that the need to increase production is to-day's real problem, although when discussing it most of us assume this to mean an increase to our own standard by the other fellow. It is the integration of our many superficial problems that we seek, and unless we find an objective acceptable to most investigators, one that can be expressed in fairly simple terms, we cannot hope to concentrate sufficiently on its solution. We cannot hope also, to convince the many that the solution is right and is applicable to them.

In the field of engineering an efficient mechanism can only be produced if each component part is produced within "limits". Taking this mechanical parallel it seems to me that each individual citizen has upper and lower limits of value. A real trouble is that we tend to measure his actualities against the lower limit without regard to the upper, largely because we do not appreciate where or how high the upper limit is. Unless, therefore, you have a clear view of man's potentialities, as represented by this upper limit, you cannot achieve what might be called Human Quality Control. It is not enough to state that God and the Devil represent these limits—they must be broken down into measurements applicable to many situations and activities, just as the individual parts of our mechanism have their own appropriate limits. Before attempting a solution, you must know what you want to achieve. As *The Economist* said recently in relation to the Transport Nationalisation Bill, "nobody knows how much good there is to do". Basically therefore, while it

only takes us a short distance along the road, the main problem of labour, as with every other activity, is firstly to establish reasonable standards of measurement against which to compare performance. It is to-day's problem that many of our apparent human difficulties are aggravated by negative complaint rather than positive comparison, and as Lord Balfour once said "most people fail because they don't know the goal they desire to reach".

Within the space of a short paper I cannot amplify this belief, but I might sum up my approach by stating that the fundamental problem of labour is that of creating standards of measurement which in approximate arithmetical expression, include man's highest common factor as well as his lower common denominator.

The scientific approach to labour problems does not differ from a similar approach to the more material problems, and an essential part of it is:

(i) To decide what performance you want.

(ii) To be able to measure it.

I believe a brief examination of our more superficial difficulties to-day will convince us that, taking a simple analogy, the selection of materials, the manufacture of individual parts, the assembly and testing of a simple engine, is a very much more scientific job than the selection of the individuals, training, the grouping together and measurement of performance of the people who make that engine.

(B) A Systematic Analysis of the Problem

If we compare the scientific approach to human problems with other such approaches the first thing striking the observer is the great amount of opinion in relation to fact. Let us take only one example—the ideal characteristics required to make a good factory manager. Every answer will vary considerably. An answer on the chemical formula for benzine will be precise and comparable. Do we think we shall ever state our human requirements in such precise terms, or do we feel that man's capacity for infinite change will make a precise forecast of him impossible? Do we think that, having defined him, he will follow the pattern? In my working environment I often feel the task is hopeless and only in the meditative quiet of study do I sense fully his infinite capacity for greatness and the rewards of unleashing man from his own bonds greater than anything the world has yet seen. Glimpses of his upper limits are occasionally seen, only to be dulled immediately by mediocrity, but enough gold has been seen to continue blasting the rock and refining the ore.

How little real research is carried out on man in his working environment! Since the dawn of the industrial revolution only two real researches come to memory. The first was by F. W. Taylor, whose cutting-tool investigations pale by comparison with his work on industrial organisation. His memory, if not all his ideas, lingers on. The other was that great investigation at Western Electric called "The Hawthorne Experiment". Taylor died in 1915 and the Hawthorne work was carried out about twenty years ago. We have had many small researches carried out by bodies like the Medical Research Council, but they are superficial in relation to the real problem. Taking one current example alone—the forty-hour week—most evidence used by propagandists compare results obtained in 1916-17 when hours were reduced from sixty-seventy to about fifty per week, a condition having no accurate comparison with to-day's problems.

Here then is a great requirement—more intensive research, on the industrial level, of some of to-day's problems; and in asking for this, may I plead for constant integration of laboratory and practical activities of the team? Never has industry shown greater willingness to co-operate on a large scale, and a job such as that done during the war in selecting army officers is an example of wide practical collaboration with the researchers.

Are there any special aspects of the labour problem worth isolating? Here are a few that time will permit of laying before you.

THE MEANING OF ORGANISATION

I have classified three principal kinds of characteristics which should be possessed by men in varying degrees. In order of importance they are:

(i) Personal.
(ii) Organisational.
(iii) Technical.

It is difficult to envisage, over a short period, any marked change in the broad level of personal characteristics, which include such factors as intelligence, jealousy and courage. Special conditions, such as war and shortages, may throw emphasis from time to time on the best or worst sides of our nature, but generally fundamental make-up varies little over a long period. It is the utilisation of innate quality, or as Dennison puts it: "control of the animal, the savage and the child in our mind" that is of greater immediate importance: briefly, the necessity to organise our own personality, and its relationship to others.

On the technical side, in many spheres, there is really no serious problem over the near future, strange though this may sound. There is a vast fund of knowledge in the world, and as the late Lord Stamp said, the problem really is to use effectively what we already have.

The real possibility of the immediate future lies in the remaining characteristics, the organisational, because these alone will enable us effectively to harness together the first and third for personal and common good. The study and the application of organisational principles represents the third stage of the Industrial Revolution.

What is Organisation? There are many definitions, and I will give you three only. Mooney and Reilly define it as "the form of every human association for the attainment of a common purpose". Mannheim defines it as "the application of technical conceptions to the forms of human co-operation". The third definition is my own: it is "to arrange the parts so that the whole shall act as one body". You will notice that the first and third definitions lay stress on action or attainment, which is often lacking in many managerial definitions.

The scientific conception of organisation has permeated but slowly through the masses and even through the managers. People talk of the "machinery" of government—a wrong term. A noble lord said recently in relation to two large groups that "the mechanical difficulties of fusion were great". The difficulties were in the field of organics not mechanics. Possibly organisation is more difficult to isolate, study and popularise than the other characteristics of Personality and Technology; and the attitude of mind to it may be illustrated by one simple example—the Organisation Chart. It is interesting to go into a business and at an appropriate moment ask about

such a chart. How often have I been told, usually by top management, that "we don't need those things here—we all know what to do". There is often a confusion and frustration among the lesser officials which is expressed more forcibly!

And yet it is so natural for people to use a map when exploring new terrain; to use a drawing when manufacturing something. The organisation chart is such a map or drawing, applied to the arrangement of people—the most difficult arrangement of all.

It is in this sphere that the scientific approach becomes so evident—or otherwise. So many managers feel that personalities cannot be arranged on paper, and I would be the first to agree if it remained there. If, however, the organistion can be expressed clearly on paper it is more likely to be understood clearly by those within it—and understanding is an essential step to achievement. Organisation, dealing with the relationship of people to people—up, down and across—is a study which should be scientifically approached, the principles isolated and tested and finally permeated more effectively through all interested in management. It will, by its tendency to avoid overlapping, underlapping, frustration and wasted effort, enable both personal and technical qualities to be utilised more effectively "for the common purpose". You have only to watch two teams at tug-of-war where, with weights equal, the better organised one has "its parts acting as one body" to witness a simple example of the effect of good organisation.

To the trained observer nothing in a business is more significant than a map of its organisation. To the trained manager it is his first study when he wishes to change any person in the organisation, at any level; to introduce a new technique; to expand, contract or promote. It is one of the most effective tools in his kit.

To design and use it he must have in his tool kit a set of organisational principles. As Fayol said: "the principle is the lighthouse which enables us to get our bearings, but it only helps those who know the way to port". "A manager knows that in technical matters he cannot depart from certain rules without risking loss of prestige. In organisation he often indulges in the most harmful practices with impunity".

For the rest of this section I will deal with a few problems which emerge from our study of the organisation chart.

Line or Staff—Which Comes First?

These organisational terms will be well known to many of you. What may not be so well known, because it is less appreciated, is the extent to which, in many fields, the staff function has gained status, unfortunately often at the expense of the line function.

From fifty years ago, when the owner or manager was literally jack-of-all-trades responsible for buying, selling, making up wages, hiring and firing, promoting, and answering complaints, in addition to his fundamental job of producing, we have arrived at the stage where we have our purchasing and sales managers, wages, personnel managers, public relations officers, and even the job of producing has been broken down in many industries to a high degree of specialisation. The direct worker has so many indirect helpers and advisors around him that he is in danger of suffocation. Worse still, he has disappeared so much from the public gaze that he is suffering from an inferiority of complex and income, while his indirect friends

take the limelight and other things. It is a fundamental concept of organisation as I know it that the line represents its real strength and must not be subordinate to the staff. Yet to-day we often find this concept violated; the spectacular growth of personnel management has taken from many supervisors and managers their essential authorities and has been responsible for many problems of transition in its search for greater human understanding. The staff function of inspection or checking, whether of quality or quantity of work produced, has tended to reduce the responsibility of the line producer for these functions. The wartime growth of joint consultation in industry tended often to short-circuit the line supervisor by making direct contacts between worker-representatives and top or personnel management. I heard recently of a graduate doing factory work who had been spoken to only twice in six weeks by his line foreman. The real boss was the rate-fixer. The tendency to employ public relations officers in many fields will isolate the responsible line officer more effectively than before, with a further reduction in his sense of responsibility. The staff may, and should, advise on both plans and their execution, but *essential responsibility remains with the line leader to plan and execute.* The true line leader knows the value of pre-digested thought and will take advice from all competent advisors—the better they are the better his final plans and performances are—but nothing should rob him of final authority and responsibility.

What are the results of the maltreatment of this organisation principle? In industry to-day we find those with better education, better training, better intelligence and potentialities being attracted to staff functions, and once in them, having the ear and the favour of the directors. Following this, because big fleas have little fleas, we find a universal relative growth of indirects and overheads not only in the Civil Service but in Industry. There really wouldn't be such a shortage of labour to-day if staff functions were better controlled. One difficulty is that not all staff workers would, if released, take direct or line jobs as their status would be reduced. Our job is to level by raising the line.

By comparison, let us look at the line members. They include the foremen, the deputies, the supervisors responsible for the principal function performed in the business, whether it be mining coal, making motors or selling books. They are not being selected, trained, promoted and paid in accordance with their responsibilities. Promotion rarely takes place from staff to line functions and the shop foreman who gets a job as personnel advisor probably finds both status and salary improved.

What is the reason for this relative subjugation of the line? It lies, I believe, largely in the growth of centralisation, and I would like to spend a short time on this most important organisational problem of labour, which I will state as "the need for decentralisation".

The Need for Decentralisation

If we are wise we will plan towards a society in which it will become more difficult for a dictatorship to create and maintain itself. The second world war was fought largely because there was no other way to finish the centralised dictatorships that had spread their destroying tentacles over the free minds of the people. Even before 1939 a slow but quite definite movement towards a centralised bureaucracy in this

country was noticed by such men as the late Lord Hewart. Faint in substance perhaps, when compared with the conditions in Germany and Italy, but quite definitely of the same shape.

When war actually broke on the world the process in Britain naturally speeded up tremendously. Centralised Government became more forceful, and with snowball-like effect produced Order upon Order to make itself, in the interests of war-winning, still more powerful. Now this was natural and necessary. What, however, was essential, once central "power" had been collected, was to decentralise it—delegate it to those who, outside the central zone, were still willing partners in the prosecution of the war. Now is not the time or place to discuss this subject further, but the Citrine Report on regional decentralization under the Ministry of Production was an example showing the necessity of making use of decentralised authority and responsibility.

So to the post-war world. The spectacle of a vast Government machine with all its knobs and levers in Whitehall is just as depressing and anti-social as the vast industrial corporation with all control, power and authority at headquarters and mere puppets at the fringes of the organisation. We should endeavour to give authority and its boon companion, responsibility, to the common man to the utmost of his ability to use his natural resources. That way lies full national vigour through the "integration of the individuals"; the opposite way lies dictatorship and the subjugation of the individual.

If this is true of the large it should be true of part of the large. It should hold true in the individual company where, if the "infallibility of management" is an imposed code in the interests of a superficial efficiency, the full natural resources of the organisation are not utilised.

The growth of large-scale units, whether Government or private, has been largely responsible for the relative increase of staff functions and authority mentioned earlier; central authority, because it often fails adequately to delegate its powers, must surround itself with advisors, and the line function becomes less and less precise and recognised.

What practical steps can be taken to decentralise? Some might say "stop nationalisation," but whatever our political views, we are all interested in improving overall efficiency of working and living, and there are many practical ways of enabling an individual to become identified with his working unit. We reach the "whole" through the "parts", and with to-day's national and international complexities, man must have a sheet anchor that he can see *near at hand*. Therefore the first essential loyalty and enthusiasm to build up is one to the smallest working group in which the individual works.

This must build up his enthusiasm to his department, his factory or office, his mine or his company. Only after these enthusiasms have been strengthened in turn are we likely to get him working for the wide objective of coal board or country. So many men want to be proud of their working environment, they like working for an efficient foreman or manager—a good firm. How often do we fail to capitalise on this trait!

During the war I had considerable experience of decentralising our company activities. We found many potential leaders who, in a small unit, could exercise

leadership and produce grand results which simply would not have been produced so consistently in a large unit; nor would leaders and workers have felt the same satisfaction. One of the most efficient factories was a converted garage, the supervisor in charge an up-graded shop steward. We organised opportunities for exercising their potential value.

One big problem of labour falls under the heading of INCENTIVE. Do we have to have piece-work or payment by results? War-time experience convinced me that if the immediate leadership were worth-while, this method of payment was not particularly necessary, so long as individual merit on basic rate was fairly recognised. This simplification alone will reduce costs and staff functions considerably, although it will still be necessary to measure results against standards set, in fact more so. It will also reduce one of the biggest causes of resentment by line workers and difficulties by supervisors, who to-day frequently devote more time to maintaining total income than total production.

The real objective of decentralisation is therefore the simple one of stimulating loyalties, objectives and efficiencies from the smallest group upwards, instead of from the largest group downwards. If practical steps are taken to achieve this we shall find the line coming back into its own, and central authority endeavouring to work itself out of a job, even if not out of its final inescapable responsibility.

One other of the many aspects of this section is worth commenting upon. How does joint consultation or worker-participation-in-management fit into our future labour structure? There really isn't much for me to say here. Surely, *all* managers accept fully the desirability of keeping all ranks informed on policy and performance as quickly as possible. Joint consultation, organised correctly, is a vital link in the chain of knowledge, and satisfaction.

What about participation in management? In a considerable working experience of joint consultation I have found that the demand of workers to take over management functions is in inverse proportion to the quality of the managers. The remedy is obvious. Many managers are leading to-day only because they are being chased.

THE SIGNIFICANCE OF THE GROUP

I want to deal now with a most important problem—the organisation of group activity. The audience confronting me to-day behaves differently as a group than as individuals. The whole problem of life is working together, but what do we know about putting the right people together—of getting the best "combination" for a given task? Frankly, very little, and it is in this field that so much integrated research is necessary. It is here, starting with the smallest group of two that we have "human association for attainment of a common purpose".

It is the fitting of the smaller into the larger and larger group that is also our problem. How should we approach it? Should we start with the large group and work downwards, or should we work upwards? We may, of course, already *have* our large group. My own approach would be firstly to reorganise at the lower level and if the Hawthorne experiments mentioned earlier told us anything, it was this fact. Let us never forget that, with all the importance of the group, it must always be built up from the individual.

A recent writer suggested that groups were living entities, like individuals.

Ingenious arguments were used, but in my view the conclusion was wrong. We must work upwards and attempt at all times to fit the individual accurately into the right place in the group jig-saw and not attempt to file too many corners off him in order to make him fit. Let us remember that, within wide limits, individual characteristics are the salt of the earth.

Are there any general rules of group organisation? I have a few, although I realise fully how little I know of this problem:

(1). The group should be as small numerically as is consistent with its task.

(2). Its task should preferably be something well-defined, and be completed as far as possible to a recognisable stage of quality and quantity by the group.

(3). Its geographical arrangement should be as compact as possible.

(4). Its leader-structure should comprise individuals having similar characteristics. A team of two fast-moving leaders would probably work better than two different types of individual.

(5). Every opportunity should be made to create confidence of the group in its leaders.

(6). A reasonable degree of job flexibility should be required of each member of the group, including the leader.

(7). Methods of measuring and rewarding individual enterprise (or lack of it) should be set up within the group.

(8). The organisational chart of the group should show clearly its relation to adjacent groups and of its individual leaders to other group leaders.

(9). The responsibility of its leaders for authoritative decision should be as great as possible.

No. 6 is worth amplification. Job flexibility is becoming gradually less in this age of specialisation and restriction and will cause many problems unless recognised. Every worker of every grade, from juvenile training onwards, should have reasonable flexibility of mind and job encouraged, between functions, between line and staff and between factories. Consider the possibility of building the shells of new houses in summer and finishing the insides in winter. How much difficulty would be met in organizing such an arrangement, and yet what possibilities exist. I wish time would permit other examples, but I can do no more than emphasise that with increased technical specialisation the credit is often reduced seriously by rigidity of organisation.

Just a few words also on No. 9. "Speed up the decision" might well be a slogan for all managers and the organisational effectiveness of any group might be measured by the shortness of the channel between enquiry and decision. Decentralisation must mean decentralisation of *authority*.

The Status of Industry

The last of the few problems I wish to mention particularly deals with status—or degree of standing in the community. What makes men strike? Why do the great majority of strikes occur among manual workers of skilled to semi-skilled trades? Very largely, I believe, owing to an inferiority complex, a lack of status recognition.

The trend of the Industrial Revolution has relatively debased the craftsman in

society, and to be in industry at all has meant that you are not really in the top drawer. Let us take a few examples. How many promising students are encouraged to train for and enter industry? Most teachers, even to-day, are biased towards other activities. Industry is to them a suitable recipient for the "C's"—because no one else will take them. How little is the manual worker regarded in relation to the white-collar worker, even in the factory itself. The girl of sixteen in the general office is probably eligible immediately for the company's pension scheme and other amenities. The highly-skilled factory worker is out of them. The office worker has decent cloakrooms—the factory worker usually has either no doors or only half doors to his lavatory, because he can't be trusted not to "mike"! He is still called a "hand" by many who ought to know better. His working hours are longer. Many other examples could be shown, but they all add up to a lack of status in society of the manual worker.

It might be thought that his good wages in many trades, his union backing, would tend to overcome this handicap, but on the subject of union membership alone this would almost seem statistically to be a direct factor in strikes, as most strikers are union members, and many white-collar members regard union membership as a lowering of status, or at least an unnecessary adjunct of it.

There seems nothing likely to stop the subdivision of labour being carried over into other activities, such as agriculture, civil service, office work, and selling, and many of the troubles of the industrial manual worker brought about by the introduction of the machine will spread to other jobs. There will be possible benefit in increased productivity, but this will be discounted by some of the current ills of manual industry. It will also involve a debasement of the present status of and satisfaction derived from those activities, so that the gap between social appeal of various jobs will narrow.

Unfortunately, this levelling by lowering is all wrong, and a more positive attempt would be to raise the present lower status of the industrial manual worker. Let us remember the vital nature of this task. Possibly less than a quarter of our total working population are paid by the hour; are classed as manual workers. They are the people we think about when we talk of increasing production. Unless we increase their status they will get less and less numerically and it will be impossible to increase their rate of output in order to maintain, let alone increase, our standard of living.

How can we attract people to their ranks?

The unions have a major task here and their somewhat belated interest in production techniques is a step in the right direction, giving sponsorship to pride in the job in addition to pride in collective organisation and political strength.

Managers must, however, as always, accept prime responsibility. We must start by selling ourselves more effectively to those who don't know us—teachers, parents, children, so that a better cross-section of society is willing to start on the factory floor and work through. We must dig out our promotion channel from bottom to very top, so that promise is rewarded by promotion. We must strengthen the line function and the line supervisors, and in doing so we must endeavour in the future world of boards and councils to give more places to the direct worker representatives and those promoted to top rank from that source. We must endeavour

through education and job rating to persuade people that skill through a trade has a value to society more comparable to other skills than it has at present. As was said by a headmaster recently: "Education has meant hitherto something which the scholarly boy did well and the unscholarly did badly. We have tended to forget the man who was educated through his trade. The tradesman who has served a full apprenticeship has often received an education as good in its way as anything that can be provided in any school. For it brings not only competence in a trade, but also the full development of those faculties that are of use for it; a sense of touch perhaps, and a sense of design, an exact appreciation of the quality of materials used, a precise awareness of the results likely to follow from given methods; and with all this what might be called harmonising of the personality, and the acquisition of a steadiness and balance of outlook which never comes unless many of our faculties are being called into play".*

Last but not least, we must in industry take even more active steps to educate our workers towards a broader conception of the business. Firstly, a greater contribution to the county college scheme of integrated industrial-educational activity among young people. Secondly, through joint consultation in its best sense, encouragement of wider outlooks and interests among all workers, to counteract the greater routine of the future and provide them with the work satisfaction they need. As working hours become shorter this need becomes greater. Thirdly, more effective education and training of all grades to increase their performance and sense of satisfaction in the job. Last, but certainly not least, the fullest development of a pride in the leaders and *units* in which they work which I stressed in an earlier section.

(c) Utilisation of Prevailing External Knowledge

The scientific approach must involve a study of other fields with the thought that something of value to your own problem is likely to be found there. The textile factory or insurance office will show me a technique I can adapt to electrical engineering and the principles and laws of applied mechanics will probably help me to work out principles of organisation. I remember years ago adapting Newton's third law "To every action there is an equal and opposite reaction". How true as applied to humans; it certainly taught me to put myself more often in the other fellow's place before I took action with him. Boyle's law, adapted to state that "the temperature of a body varies in proportion to the pressure applied", could certainly be applied to us. A recent speaker referred to the comparison of resonance as studied in radio and similar fields, with the period of vibration of the individual. He used the interesting term "Human Harmonies". Keeping in the radio field one might say we have to-day too much static interference!

A prominent American manager derived great benefit from the biological writings of Sir D'Arcy Thompson in his study of group organisation. A law of friction states that "friction is directly proportional to the pressure between the surfaces". How easily applied to the organisation structure, where the contact surfaces are departmental supervisors!

There are so many examples I could quote, but enough have been given to

* Mr. Walter Oakeshoot, St. Paul's School.

illustrate how much worth while would be more intensive search of prevailing knowledge in other fields and its adaptation to the newer study of organisation. I have, however, heard so many say that great danger lies in adapting or stating principles in human activities that I feel I should give a moment's consideration to this viewpoint. There *is* a danger if principles are applied rigidly to each individual case, instead of being merely one of many managerial tools. It is like trying to locate a friend's address. If your principle helps you to track him to Southend, possibly even to a certain street, surely you have been helped, even if individual treatment is then necessary to locate his actual house. Our principles may assist group organisation, but we must never forget consideration of the individual.

One danger in stressing the type of scientific approach made by workers in other fields is that it is so easy to lose sight of the soul. Most sciences tend to become more complex as they progress and even in personnel management the "welfare" approach is giving way to the statistical expert the pseudo-psychologist who looks at man through logarithm-lined glasses.

The associated field of psychology is of course one of great interest to the practising manager. One difficulty, as with all new things, is the lack of agreement among psychologists themselves. Is a medical background necessary? How much should the special problems dealt with by the psychiatrist be used to line up an approach to more normal people? How much importance can be attached to the intelligence test as an index of selection and placement? What degree of accuracy can be attached to tests for other characteristics required in selecting men?

One thing is certain: too little contact with industry is maintained by psychologists generally, and the amount of collaborative research is much less than is desirable. A greater measure of systematic contact with industry will tend to ensure reasonable balance between theory and practice, and I hope, between the number of investigators and the number of workers. To-day's tendency for too many people to hold a microscope focussed on too few manual workers, must be recognised. Indeed, one of the reasons for an inferiority complex of many manual workers is that *they* alone are studied with a stop watch, camera and slide-rule. Physician—heal thyself!

(D) A Clear Statement of the Possible Solution

In my incomplete survey I have mentioned only a few aspects of our labour problem, mostly on a broad plane as befits my audience. Summarising, we discussed them in this order:

(1). The meaning of a scientific approach.
(2). Its necessary emphasis on conclusion as an end to investigation.
(3). Industry's relative importance as a field of activity.
(4). The problems created by increased specialisation.
(5). The essential requirement of defining what we want from labour and being able to measure it.
(6). The need for greater integrated research.
(7). The importance of the organisational characteristic.
(8). The relative importance of the "line" function.
(9). The need for decentralisation.

(10). The importance of group activity and understanding.
(11). The necessity for improving industrial status.
(12). What we can learn from other fields.

Finally, I would like to say a few words on one of the most important aspects of the scientific approach; it is:

(E) Acceptance of Responsibility for Bringing Proposals to Fruition

Out of debate must come decision.
Out of decision must come fruition.

These axioms are more than ever significant to-day when the initiative for bringing things to completion seems at a low ebb. I mentioned earlier that an essential element in my definition of organisation was achievement or attainment, and one real shortage to-day is the initiative and courage necessary for this purpose. So much is known, so little *individual* responsibility—for applying it.

I took a team to U.S.A. recently and after intensive investigation we concluded that the acceptance of direct responsibility for decision and action was one of the biggest factors in their greater results. More people had an enterprising and alert attitude of mind which resulted in more intelligent and effective working.

How many of your associates or subordinates can you really trust to complete the execution of a decision in good time? How many put ideas to you instead of the other way round? The problem of building such characteristics is great it comes naturally to a few—in others it is often below the surface and can be brought out by some of the things discussed earlier.

There are at least three good ways of building up these characteristics. They are:
(1). Setting individual targets.
(2). Kindling individual enthusiasm.
(3). Taking chances with the potential managers.

Let us deal briefly with them, in order: I said earlier that one of our greatest labour problems is lack of a measuring system, and so we come full circle to the great need for defining more closely what we want from people, not so much in mass, but individually. That is why the art of setting continuous targets is a managerial responsibility of the first order.

There are many things to watch in setting them, but a few of the more important are:

(*a*) They should preferably be set in consultation with those who have to achieve them.
(*b*) They should preferably include the competitive element.
(*c*) They should preferably include the time element.
(*d*) They should cover *all* grades of labour.
(*e*) The time element should be as short as is reasonable.
(*f*) They should be used to check performance and establish responsibilities.
(*g*) They should relate to individuals as far as possible.

Amplifying the last one only, a production target should not be set against a factory, a mine, or a department. It should be set against Mr. Jones the Manager, or Mr. Smith the supervisor. He in turn will set targets for Bill Brown and not

No. 3 Group—and so on down the line. Each should personally present and explain his results, as part of his line responsibility.

How can we encourage individual enthusiasms? Once again by bringing things down to the individual as much as possible. We should avoid organisation charts having departments only stated, as is often done. The chart must be individualised. We must encourage individual suggestions and regard *each one* as a potential winner, not as a "sop" to joint consultation. We must encourage normal lines of contact. Let us speed up the procedure, not short-circuit it. We must show by example that promotion right to the top is possible to those who work for it. We must make a rapid two-way job of forming company policy and, not least, we must pay for individual merit generously without being intimidated by those who don't merit it.

And now for taking chances. One of the best ways to catch an epidemic is to expose oneself to it. Similarly a good way to train for responsibility is to expose the person concerned to intimate and continuous contact with it. There are so many ways by which individual responsibility can be built up which are ignored to-day, and obviously the two last methods discussed will do much to help individually; indeed, the whole theme of my talk has been one of emphasis on building from the *individual* upwards. Starting with the apprentice, we should make it continuously clear that we will match everything he does for himself, and we should allow him free opportunity for broadening the basis of his outlook, while giving him a first-class technical training to increase his own confidence and of others in him. We should encourage shop stewards to accept greater individual responsibility, which can only come if we broaden their understanding by sub-committee and other work which allows for reasonable decision to be made on many points instead of being purely advisory. Responsibility can only be built up with authority. We should insist that every supervisor and manager is individually responsible for his job, and if we do this no supervisor will worry much about joining a union which, by its nature, has sponsored collective security and action. If he does combine with his fellows outside I hope it will be more and more in the direction of professional improvement. Certainly, combination with his fellows inside will be by greater personal contacts and not by building paper bridges and mistaking regulations for management.

We will, I hope, give the supervisor and manager much better training in future. It is significant to me that with all the talk of nationalisation, little is done to build the managers, their responsibilities and training. Perhaps it is assumed that they will just fall into line. Certainly the manager of to-day is individually and collectively a small voice in the wilderness, and he might be pardoned, even after reading Burnham's *The Managerial Revolution*, for imagining that to-day he is being robbed of his authority, even if not his responsibility.

Now, before I conclude, let me say that I and others have much to do before we achieve the programme set before us. Such a task represents my target, and I realize fully how much more there is to do. In other words, I know what I want to achieve, which is an essential ingredient of ultimate success.

Finally, we are supposed to be in the century of the Common Man, but let us never forget that it is the uncommon man also who should be recognized and

reasonably encouraged. At least we should show him no more than the usual amount of resentment. We should try to build the Common Man up to the uncommon level, and not the reverse, and remember that, with respect to the multitude, the quality of a single man may be as a spring rising in the mountain which, once started along the right channel, may become in due course a mighty river of progress.

DISCUSSION

Mr. J. A. DUNLOP: Mr. Puckey mentioned the age-old problem of incentive and I expect he was referring to cash incentive. Could he enlarge on his own experience? It looks as if he has abolished it.

Mr. W. C. PUCKEY: I hope I did not give the impression that we had abolished the cash incentive or that it is not necessary. What I meant was that if you build up the supervision and responsibility for leading the people correctly, I do not believe the necessity for a variety of financial carrots is quite so great. I know I should be very reluctant immediately to eliminate the various carrots—bonus schemes and so on—which are dangled before our workers. However, during the war we had many opportunities with manual workers of carrying out experimental work where piece-work was eliminated and we worked on flat payment, and in those cases where we had real, live, enthusiastic leadership and the people realised they were working for a definite purpose the necessity for piece-work was largely eliminated. But if one attempted to cut that out too quickly one would for a long time get considerably less output.

Once again we come to the question of status. In the average industrial company to-day it is safe to estimate that less than 50 per cent. of the people in it are working on an individual payment-by-result scheme. It is nearly always the direct workers only who are working on that scheme. The people who are not directly on production work are not generally paid in this manner and yet we pay little attention to what they do and are focussing our attention on a very small number of people. Perhaps what is good for one is good for another. Either we should pay more attention to the output we want from the indirect people or we should work towards a condition where we will make those on direct incentive schemes more appreciative of their place in the industrial community and give them broader incentives than they often have at present.

Mr. J. R. JARMAN: With regard to incentive there is the question of what incentive there is to efficiency in management. With experience both of industry and the Civil Service one must realise that there are many efficient units working side by side with units which are inefficient from the management angle; and with increased nationalisation and bureaucracy any large business does have to see where the reward for applying principles of scientific management will apply. If they apply within a free enterprise system they are deducted by excess profits taxation. If it is within the Civil Service, the inefficient unit jogs along in its old way covered by the more efficient unit, and the country suffers but the inefficient unit does not.

Mr. W. C. PUCKEY: Your point appears to be that it does not pay to be efficient in free enterprise and it is impossible to be efficient in the Civil Service anyway! To a certain extent that is a pessimistic outlook, because I think you can find efficient units in the Civil Service and inefficient units under free enterprise, as well as the reverse. The main reason why I am stressing the encouragement of individual enterprise in an organisation is because I fail to see much movement towards the decentralisation of responsibility and authority. There is too much attempt being made to collect power into the centre and too little encouragement being given to those people at the fringes. You say "What incentive is there for management?" I might say "What incentive is there for me to do a good job?" There are quite a number of ways by which we can be induced to work more vigorously. I like to feel that I am working for someone who is worth working for and a company which is worth working for, because I like the job it

does, the ideals it stands for, and its general outlook on society. That makes me realise that I am attached to something worth while and I will work harder. You must work for someone you respect; if you do not, you will never bring out the potential value inside yourself. At the same time, in working for an individual, that individual must be identified with the company he is in. So if you are working in a department you must be proud of your department. That must be built up into pride in the company you work in, and in my view one of the reasons why a lot of people are not to-day working as they should is that we have discouraged people from working for their own small immediate objective. There has been too great a tendency to visualise things in the broadest sense. Too much has been said about the Coal Board, for instance, and large entities of that sort. I think this craze for organisational bigness one of the things that are wrong to-day. Incidentally, my conception of a manager is not only those of us who are called managers. Every man is equally a manager if he is in charge of someone else. It is therefore essential that we should break down management skills and loyalties and recognise that loyalty and pride within the small group must be there if the larger group is to be successful. To-day I believe we tend too much to work from the top downwards and our ideals and inspirations do not permeate to the individual workers.

Mr. F. S. BUTTON, C.B.E.: Mr. Puckey's address covers so wide a field that it is impossible to deal briefly with more than one very small part of it. The thing that appealed to me was the idea of "industrial democracy". We used to say in the old days in the workshop that shop stewards, works committees, welfare committees, suggestion committees and so on were all very excellent things; but where are they going to lead us? What is the power we are prepared to grant to those capable of exercising it? What price are we prepared to pay for this loyalty from workpeople? I would limit the power granted to those at the point of production only by the responsibility with which they exercise the power already granted to them. I am sure from the paper which we have heard, that that is the first question, the key proposition of the whole address.

THE CHAIRMAN: I should like to make one or two observations based partly on the paper. My first comment on the paper was the width of its sweep. It covers many matters that involve deep and basic questions, not merely of organic and economic structure, but of individual and human personality, none of which have been resolved and most of which are still in the very early stages of experiment. Take, for example, the evolution of industry over the past fifty years. Clearly the trend has been in the direction of the big unit and it is clearly the application of science and invention that has made it easier to produce things in the mass for the many than a small number of high-quality goods for the few. It is this change from individual specialisation to mass production which has brought about the large producing unit. Once you get that, you get all the problems associated with any form of central government. Just as the problem of devolution has and is presenting itself in the political sphere, and will do even more, so in the industrial sphere that same problem is raising its head. It is impossible to have any large unit, whether it is an economic or social or political one, without having some major principles of policy running right through the unit. It is impossible to have cohesion in any firm, organisation or enterprise operating on a very wide basis—a national basis for example—unless there is somewhere a policy which can be transmitted down to guide the various units. I would say this, that I do not believe you can evolve industrial statesmanship out of small units. One of our misfortunes is that industry has jumped ahead so quickly that we have not evolved persons to handle the enormous power at industry's disposal. We are finding all sorts of problems in consequence of that lack. The large unit involves a wide social responsibility and consequently and eventually involves a higher quality of people at the head of that organisation. I am not suggesting that we have got them yet but I believe that they will develop, and when they do they can study how to get the highest of incentives. I believe that the cash incentive is the lowest. It is a purely temporary thing. Eventually when we have satisfied the main material needs we must satisfy the great impulse in the individual to do something he really believes in.

I cannot imagine the small unit getting psychologists in and so on. The man running a small business has need of only his own brains because he is in constant contact with the individual members of that unit, but the problem is different with a unit employing 300,000 employees. How are the employers to obtain contact with the individual workers? That contact has got to be transmitted down through a chain of human beings none of whom is so easily susceptible to exact instructions as the mechanical parts of a machine. You always find in this chain that something goes wrong because of individual shortcomings and characteristics.

Even if that was achieved in a perfect way it would not solve the problem, but only part of it. I believe that it is completely impossible for the average man to get control under modern economic conditions, of the basic thing that concerns his livelihood except through collective action. How is he going to do it? There must be some policy formed between man and man. The whole basis of trade unionism depends upon the assumption that there are some things people have in common. Hence collective action and hence the trade unions. When it comes to the sphere of policy covering the whole of an industry, how else can it be done but through collective action? I think it would be impossible.

We have listened to a very thought-provoking paper. To my mind it sets out clearly what everybody thinks who thinks at all on this subject. How difficult to apply that to the things we know it should be applied to. How do we know what efficiency is? Is it merely the ability to give orders? Are there no other qualities beyond that needed? We work on a hit-and-miss principle in this life. Six men out of perhaps hundreds are selected for any particular spot. Because one man has personality he succeeds to a post. How do we ever know what we have lost in regard to the others? Such questions will indicate to you what a depth there is in this paper. I think our lecturer has achieved his task admirably in this paper, and I ask you to accord him your thanks for presenting it.

Miss C. HASLETT, M.P.: I should like on behalf of the Council of the Royal Society of Arts to thank the Chairman for presiding here to-day. When we planned this series of lectures we were anxious not only to have first-class lecturers but chairmen who would give dignity and importance to these lectures and we were very grateful to Lord Citrine when he consented to preside to-day. We thank him for that and for adding the status of his name to this series of lectures.

The vote of thanks was carried with acclamation, and the meeting then terminated.

NOTES ON BOOKS

LEATHER IN LIFE, ART AND INDUSTRY. By John W. Waterer. Faber and Faber. London. 1946. 50*s*.

Leather in Life, Art and Industry—"being an outline", says the title-page, "of its preparation and uses in Britain yesterday and to-day together with some reflections on its place in the world of synthetics tomorrow"—by John W. Waterer, is not only an important contribution to the study of craftsmanship and design in leather, but the most exhaustive and authoritative work on the subject in all its branches that has yet appeared. It will certainly take its place as a standard authority of the future, beside such classics as Hartshorne on Glass or Britten on Clocks. The publishers too modestly describe it as a "popular" book, but it is one for the student as well as the general reader, since it is carefully annotated, uses its technicalities helpfully and with judgment, and possesses a full bibliography. There is, too, an admirable Glossary of Leathers, from which one may easily discover such useful information as of what leathers one's best gloves or one's shagreen cigarette case are made (the latter from the small skins of the Mediterranean

ray-fish), or what has been the treatment which justifies one's heaviest shoes in describing themselves as "willow calf".

No one could be better fitted to have undertaken this task than Mr. Waterer, who is himself a manufacturer of leather goods, a "National Registered Designer", and an ardent champion of better design in industry—that theme on which the recent "Britain Can Make It" Exhibition played so wisely and delightfully as to enchant even the dullest of us. His book is a model of design and craftsmanship, clearly planned, held together in all its diversity by the author's insistence on the community of interest between every worker in and every user of leather, and most aptly and gracefully illustrated. The illustrations are a fascinating feature of the whole work: in addition to the many instructive cuts in the text there are over 100 beautiful plates, which range from early engravings and woodcuts (such as the reproduction of a Bodleian broadsheet of the famous "Leather Bottel" song, or the notable series of the arms of the great City Companies connected with the leather industry) to many fine examples of modern photography, especially of industrial processes and of trade and fashion advertising. Mr. Waterer divides it into three parts—the Past, the Present and the Future—and it is a measure of his achievement that the reader who, like Mr. Hardcastle, loves best "everything that is old", does not complacently close the book at the end of the General Historical Sketch which comprises the Past, but proceeds with equal delight to the Present and the Future.

The Past covers a wide field. Mr. Waterer first discusses the great antiquity of the use of dressed leather as a world-craft, and then pursues a more detailed study of its use in Britain up to the time of the Industrial Revolution. The variety of leather purposes that emerges from such a survey—apart from the more obvious sandals, shoes, belts, harness, gloves, and so forth—is amazing, from the armour of overlapping laced leather scales and the hide chariot-tyres of Egyptian and Sumerian days, to the much-loved and much-sung Leather Bottels and Black Jacks or Bombards (the leather bottles' big brothers) of medieval England, which so adequately held "your Beer, Ale or Wine". Later came the beautifully made and most durable leather buckets of earlier fire-fighters, especially the great Fire Insurance Companies, the seventeenth-century soldier's buff jerkin, and even the eighteenth-century child's little 3 in. long horn book, made of cattle-hide and transparent cattle-horn, from which he learned his criss-cross row. It is good to realise that, whatever its purpose, early English leather work of high quality seems to have had no equal: this is a point of which Mr. Waterer never loses sight. The story of the different crafts which produced this variety of goods is inevitably bound up with that of the great Trade Guilds and later Livery Companies which organised the many departments of the leather trade. This story Mr. Waterer traces with care and scholarship, showing which leather crafts have now vanished or, more usually, been incorporated with others, such as the Bottelers, the Pursers and the Hornmakers, and which survive to-day as powerful chartered Companies which, he thinks, might do more for the encouragement of their ancient crafts and trades than they at present do. These seven great bodies are the Leathersellers, the Glovers, the Cordwainers, the Girdlers, the Saddlers, the Skinners and the Curriers. Their activities have naturally varied in the course of years. The Leathersellers, for example, once dealt mainly with those tags and laces which were both decorative, on a slashed garment, and also useful, for holding together one's doublet and hose or lacing on the plates of a suit of armour. But the Cordwainers still preside over the "Gentle Craft" of shoemaking, at which both master and man once worked together in such friendliness and gaiety, as the Elizabethan Dekker so delightfully describes in his rollicking comedy, *The Shoemaker's Holiday*.

From this fascinating and exhaustive study of the Past, Mr. Waterer proceeds to the Present, in which he deals with the subjects of what leather is, how it is made, how the industry is distributed in Britain (a most interesting chapter this, emphasising the values of local tradition in a great industry), and, again, to what varied purposes it may be put. Science and engineering now play their part in the working and preparation of leather:

the photo-micrograph enables such bodies as the British Leather Manufacturers' Research Association to study the structure of hides in the raw and tanned conditions, and there is machinery so precise that it can split a hide horizontally into a layer of ·5 mm. thickness. Leather has, besides, now turned its face a little more in the direction of current fashion demands than of old. With regard to this point however, Mr. Waterer's scale of values is a fine one, and he wisely deprecates a foolish pandering to ephemeral fashions, especially in the matter of dyeing, and insists that the artistic element in leather production must never be lost sight of—that people should, in fact, accept leather for what it is and not as a camouflaged product. This section of the Present includes chapters on Gloves, Footwear, Saddlery and Harness, which are in themselves admirable historical surveys and make delightful reading; as, to the feminine reader especially, does the chapter on Handbags. Once again, in the four first fields, English workmanship and achievement are second to none, and, in the matter of handbags, English goods have been supreme since 1914, so Mr. Waterer claims, though this is possibly debatable. The Book-binding trade has another charming chapter to itself, and it is amusing here to recall that an Oxford bookseller of the eighteenth century once advertised his skill in this direction as an ability and readiness to "clothe naked authors". Finally, the story of Luggage, ranging from the "male" of Chaucer's Pardoner (with its surprising collection of faked relics), through the medieval coffer, the seventeenth-century hair trunk, and the Victorian suit-case, weighing a good 60 lb. *empty* (porters were nothing accounted of in those days), to the modern light case for air travel (so cleverly fitted with hangers and folders for coats and dresses), is a complete commentary on transport through the ages.

And so Mr. Waterer comes to the Future. Here, although he views with some concern the synthetic and the substitute, he has no real fear for the future of this ancient and honourable industry, for there is no adequate substitute for leather, and never can be. But he does emphasise two crying needs for the assurance of its survival: design and co-operation. Insistence on sound design is, as he has repeatedly pointed out in the course of his book, vital to the leather industry. In spite of the existence of such bodies as the Saddlers' and Leathersellers' Technical College, the Cordwainers' Technical College, and others, better facilities for education and for research and development are still much needed. It is here that he feels that the great Livery Companies still ostensibly concerning themselves with leather might re-establish their old close connection with the industry. Meanwhile much is to be hoped from such newer bodies as the Council of Industrial Design or the British Colour Council, each of which can help in the encouragement of research. The second great essential is co-operation in the allied industries, on the lines of the admirable co-operation in the dress and fashion industries which France has brought to such perfection: artist and manufacturer, as Mr. Waterer says, *must* come together and accommodate themselves to new conditions. That is indeed the sum of his recommendations, and one can only devoutly hope that development of this great industry will be along these lines and that the Future as well as the Present and the Past will prove that there is still "nothing like leather".

One of the lighter aspects of Mr. Waterer's book has, indeed, been the way in which he treats this famous dictum, chaffing both his readers and himself over it from time to time. It is, he implies, the sole piece of information about his subject that the average person really possesses, and he regards it, too, as the inevitable King Charles's Head of his own particular "Memorial", which he consciously keeps out until it triumphantly emerges as his final word and Epilogue. So it is not really quite fair to quote it back at him at the end of this review—though one could hardly find a phrase that expressed more neatly and briefly an overwhelming pride in material and craftsmanship. May one adapt for him, instead, the charming words of the old and much-loved song of the "Leather Bottel" and "wish him joy where'er he dwell", for he has "devised" a noble and a beautiful book?

NORAH RICHARDSON.

RUBENS: THE CHÂTEAU DE STEEN. Introduction by Neil Maclaren.

VERMEER: LADY AT THE VIRGINALS. Introduction by Benedict Nicolson.

Gallery Books Nos. 11 and 12. Lund Humphries. 4*s*. 6*d*. each.

In autumn tints, two more little Gallery Books flutter from the press on to the reviewer's table like drifting leaves in Vallombrosa. Edited by that discerning publisher, Mr. Paul Wengraf, the latest additions to the series deal with two seventeenth-century masterpieces, of Flemish and Dutch origin: the lyrical landscape entitled "Château de Steen" from the National Gallery, and the tranquil interior usually called "Lady at the Virginals" in the Royal Collection. Their appearance is timely, for thousands of visitors have now had an opportunity of studying Vermeer's picture at Burlington House, and Rubens's "Summer" landscape (which has some affinities with his "Château de Steen") may be seen there also. Indeed, it is well to see the originals before reading these appreciations, for the reproductions of the pictures, as well as details of them, are in monochrome, Rubens's colour scheme being only briefly described by Mr. Maclaren, while Vermeer's is ignored in Mr. Nicolson's otherwise minute description of the room in Delft.

As Mr. Maclaren observes, Rubens is still thought of mostly as "the painter of figure subjects—religious and historical scenes, allegories, mythologies—above all, as the painter of splendid and almost too sumptuous nudes". But towards the close of his dazzlingly successful career as painter and diplomat Rubens acquired the lordship of the manor of Steen, and on this lovely estate between Brussels and Malines he painted —purely to please himself—those landscapes from Nature which came to be recognised as a brilliant facet of his many-sided genius. It was in this enchanting Flemish countryside, not long before his death in 1640, that Rubens painted "The Château de Steen"—a canvas that was to cast a powerful spell over the leading English landscape painters of the period, and to place Constable's later landscapes—notably "The Hay Wain"—unmistakably in its debt. Conceived as a pendant to the "Rainbow Landscape" (now in the Wallace Collection), the Château painting is most impressive for the immense spaciousness of the panorama that extends from the foreground eminence to the far blue horizon. Every detail in this great canvas—the market cart, the crouching figure of a man stalking partridges, the red brick château seen through the trees on the left—is miraculously observed and painted, and yet so subordinated to the gen eral effect that nothing distracts the eye from following the lines of trees over gently undulating meadows, with here and there a gleam of water, until it rests at last on the distant wooded sky-line. "The Château de Steen" is the supreme expression of the painter's landscape genius, and it is to be hoped that Mr. Maclaren's concise and enlightening monograph will tempt many readers to study the masterpiece afresh.

Mr. Benedict Nicolson, an experienced member of the Committee responsible for the selection and hanging of the King's pictures at Burlington House, has clearly enjoyed the task of introducing us to one of the Crown jewels at Buckingham Palace, which at present hangs between two of the finest Rembrandts in Gallery IX of the Royal Academy. There are many features to observe in Vermeer's canvas which shed light both on the period and the artist's method of painting and, as we should expect, the author subjects every detail to the closest scrutiny. Anything that can be gleaned from a single picture that contributes to the slight knowledge we possess of this enigmatic master and his methods is worth expounding, but—*unless* they have this significance—it is difficult to see what useful purpose is served by a minute description of the various objects in a room which are clearly recognisable in a number of excellent reproductions. Thus: "The top of the lady's head exactly coincides with the rim of the mirror and her dress assumes the classical structure of a fluted column (Fig. 7). Hemmed in between the lid of the virginal and the knife-edge of the picture-frame, the man is permitted no freedom of movement (Fig. 6)"—tells us no more about these figures than we can see for ourselves; criticism which is purely descriptive may be requisite in the absence of illustrations, but here it is surely superfluous.

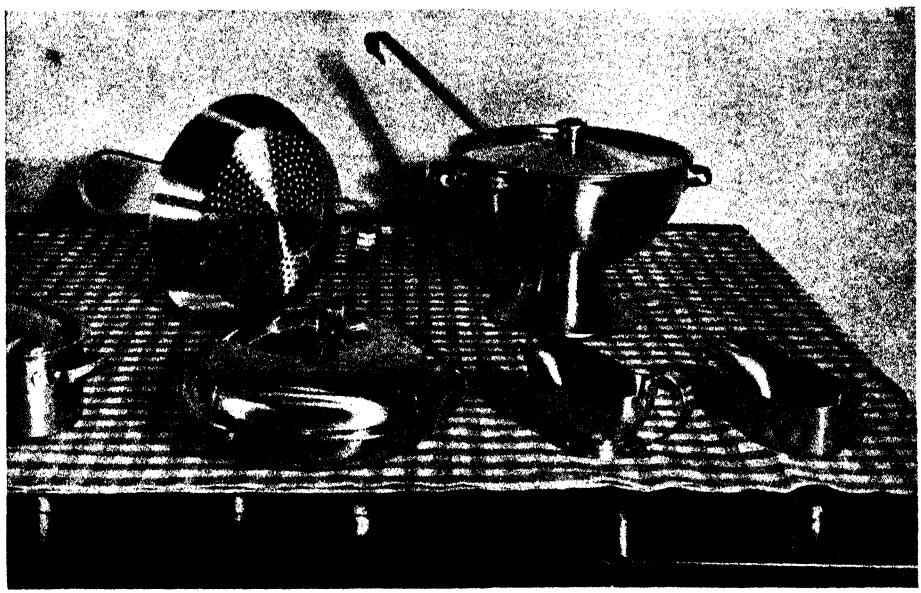
However, this is a negligible fault, and Mr Nicolson is not concerned for long with an inventory of articles. Vermeer, as we know, delighted in the scrupulous and unemotional rendering of animate and inanimate objects in his interiors and, as the author acutely remarks, one is tempted to re-christen this picture "An interior with figures". But every detail in it is fascinating, not least the virginal; and it is delightful to find a reproduction of an almost identical musical instrument in the *Musée Instrumental* in Brussels, dated 1620, with the same tiny keyboard and a Latin inscription on the lid.

Both writers wear their learning lightly, and their introductions are among the most agreeable of the dozen appreciations that have appeared in this series.

N. A. D. W.

GENERAL NOTE

DANISH DOMESTIC DESIGN EXHIBITION.—An exhibition has been open from February 21st to March 15th, at the Royal Institute of British Architects, which aimed at presenting a picture of how the people of Denmark are equipping their homes to-day.



Reproduced by courtesy of the Arts Council of Great Britain.

Kitchen and table ware of stainless steel, from the Exhibition of Danish Domestic Design

Exhibits included furniture, china and glass, silver, textiles and pottery. These were laid out to illustrate the typical arrangement and character of the living room in Denmark. The room is warmed by central heating or by a large stove, and the window rather than a fireplace is made the focus of the room. Windows are often adorned by miniature gardens or window boxes. The panes are large and undivided, and light-coloured furnishings and wall papers are favoured to make the most of the light during the dark winter. The furniture illustrated the Danish preference for leaving wood in its natural colours, and shows marked similarities to English traditional designs. Collapsible prefabricated furniture was also shown.

Along with the silverware were exhibited attractive stainless steel cutlery and utensils, developed during the war-time shortage of silver. The new steel resembles silver in texture and matt surface. Specimens are shown in the accompanying illustration. The textiles are the products of a tradition to which home handcraft still contributes a great deal.

The exhibits were assembled by the Society of Danish Handicraft and Industrial Art, and the exhibition was arranged by the Arts Council of Great Britain, the Council of Industrial Design, and the Royal Institute of British Architects.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, MARCH 17..Electrical Engineers, Institution of, at the Engineering Society, **Chester.** 6.30 p.m. J. S. Pickles and W. H. Wills, **"Rural Electrification. The Use of the Single-Phase System of Supply."**

Geographical Society, Royal, S.W.7. 5.30 p.m. T. W. Freeman, **"Irish Agriculture."**

TUESDAY, MARCH 18..Chadwick Trust, at the Westminster Hospital Medical School, 17 Horseferry Road, S.W.1. 5.30 p.m. Professor W. M. Frazer, **"A Medical Pioneer in Sanitation."**

Chemistry, Royal Institute of, at the Grand Hotel, **Manchester.** 7 p.m. Sir Henry H. Dale, O.M., G.B.E., **"Chemistry and Medicinal Treatment."**

Dyers and Colourists, Society of, at Field's Cafe **Huddersfield.** 7.30 p.m. Dr. F. Townend, **"The Use of Acids in Wool Dyeing."**

East India Association, at the Overseas League, S.W.1 2.30 p.m. Dr. Anwar Qureshi, **"The Economic Basis of Pakistan."**

Electrical Engineers, Institution of, at **Leeds University.** 7 p.m. J. Hacking, **"The Generation and Wholesale Distribution of Electricity."**

Eugenics Society, at Burlington House, W.1. 5.30 p.m. Dr. E. B. Ford, **"Recent Advances in Genetics."**

Hull Chemical and Engineering Society, at the Church Institute, Albion Street, **Hull.** 7.30 p.m. E. C. Craven, **"Relativity; An Unorthodox View."**

Industrial Transport Association, at the Royal Society of Arts, W.C.2. 6.30 p.m. Brigadier W. E. Blakey, **"Army Transportation Services in War Time."**

Manchester Geographical Society, in the Geographical Hall, **Manchester.** 6.30 p.m. Donald H. Griffiths, **"On the Trail in Arctic Lapland."**

Manchester Literary and Philosophical Society, at the College of Technology, **Manchester.** 5.30 p.m. Professor John Read. **"Historic St. Andrews and its University."**

Petroleum, Institute of, at the Engineers' Club **Manchester.** 6 p.m. Dr. Whalley, **"Progress on the Synthesis of Fuels and Lubricants."**

WEDNESDAY, MARCH 19..Electrical Engineers, Institution of, W.C.2. 5.30 p.m. L. F. Broadway, **"Velocity Modulation Valves."**

At 110 High Street, **Portsmouth.** 7 p.m. I. S. Fraser, A. A. Read and B. E. Vieyra, **"The Electrical Engineering Aspect of Degaussing."**

Kinematograph Society, British, at Film House, Wardour Street, W.1. 7.15 p.m. W. Salter C. Tomrley and Bretton Bird, **"Preparation for the Final Sound Track."**

Physical Society, at the University, **Manchester.** 10 a.m. (1) J. P. M. Prentice, **"Meteors."** (2) J. G. Porter, **"Comets."** 2 p.m. (3) A. C. B. Lovell, **"Experimental Work on the Radio Echoes from Meteors."** (4) N. Herlofson, **"The Theory of Meteor Ionization."**

THURSDAY, MARCH 20..Electrical Engineers, Institution of, W.C.2. 5.30 p.m. E. P. G. Wright, **"The Modernization of the International Telephone Service and its Reaction on National Telephone Systems."**

At Trinity College, **Dublin.** 6 p.m. F. Kelly, **"The Patenting of Inventions."**

Fuel, Institute of, at Radiant House, Bold Street, **Liverpool.** 6.30 p.m. F. Aldred, **"Water Treatment."**

Royal Society, W.1. 4.30 p.m. (1) H. D. Megaw. **"Temperature changes in the Crystal Structure of Barium Titanium Oxide."** (2) C. W. Bunn and E. V. Garner **"The Crystal Structure of two Polyamides "nylons")."**

University of London, King's College, W.C.2. 5.30 p.m. John Lehmann, **"Contemporary Greek Poetry."**

FRIDAY, MARCH 21..Electrical Engineers, Institution of, M. E. Haine, **"The Design and Construction of a new Electron Microscope."**

Royal Institution, W.1. 9 p.m. Professor D. Brunt, **"Where to Live—A Meteorological Problem."**

SATURDAY, MARCH 22..Chemical Engineers, Institution of, at College of Technology, **Manchester.** 3 p.m. H. R. C. Pratt **"Purification and Azeotropic Dehydration of Acetonitrile."**

Horniman Museum, S.E.23. 3.3 op.m. Dr. W. E. Swinton, **"Giants of the Past."**

MONDAY, MARCH 24..Electrical Engineers, Institution of, at the James Watt Memorial Institute, **Birmingham.** 4 p.m. H. G. Booker, **"The Elements of Wave Propagation using the Impedance Concept."**

At Neville Hall, **Newcastle-upon-Tyne.** 6.15 p.m. H. A. Thomas, **"Industrial Applications of Electronic Techniques."**

Geographical Society, Royal, S.W.7. 5.30 p.m. Dr. R. Cyriax, **"The Conquest of the North-West Passage."**

Philosophical Society, at 12 Queen Anne's Gate, S.W.1. 5.15 p.m. R. E. D. Clark, **"The Spheres of Revelation and Science."**

Rubber Industry, Institution of the, at the Engineers' Club, **Manchester.** 6.15 p.m. F. E. Brown. **"Engineering Economy in the Rubber Factory."**

TUESDAY, MARCH 25..Kinematograph Society, British, at Film House, Wardour Street, W.1. 7 p.m. H. K. Bourne and E. J. G. Beeson, **"A Discharge Projector Lamp for Studio Lighting."**

WEDNESDAY, MARCH 26..Kinematograph Society, British, at the Wellcome Foundation, 183 Euston Road, N.W.1. 7.15 p.m. H. S. Hind. **"Problems of 16 mm. Projection."**

THURSDAY, MARCH 27..Aeronautical Society, Royal, at the Institution of Civil Engineers, W.1. 6 p.m, Air Vice-Marshal E. B. Addison, **"The War in the Ether."**

Electrical Engineers, Institution of, at the Philharmonic Hall, **Liverpool.** 6.30 p.m. J. Hacking, **"The Generation and Wholesale Distribution of Electricity."**

Sound Recording Association, British, at the Royal Society of Arts, W.C.2. 7 p.m. P. T. Hobson, **"Developments in Magnetic Wire Recording."**

Textile Institute, at the College of Technology, **Belfast.** 7.30 p.m. Dr. R. G. Fargher, **"Trends in the Continuous Processing of Textiles."**

FRIDAY, MARCH 28..Electrical Engineers, Institution of, at the Electricity Showrooms, **Rugby.** 6.45 p.m. W. Szwander, **"Power Supply for Generating Station Auxiliary Services."**

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5 p.m. (1) J. A. Sumner, **"The Norwich Heat Pump."** (2) T. F. Thomas, **"The Air Cycle Heat Pump."**

Physical Society, at the Imperial College of Science and Technology, S.W.7. 5.15 p.m. (1) C. Gurney, **"Delayed Fracture in Glass."** (2) R. A. Sack, **"Extension of Griffith's Theory of Rupture to Three Dimensions."**

Royal Institution, W.1. 9 p.m. Sir Harold Spencer Jones, **"Eclipsing Variable Stars."**

SATURDAY, MARCH 29..Foundrymen, Institute of British, at the Waldorf Hotel, W.1. 2.30 p.m. C. D. Pollard, **"Grey Iron Die Castings."**

Horniman Museum, S.E.23. 3.30 p.m. W. R. Phillipson, **"Plant Partnership."**

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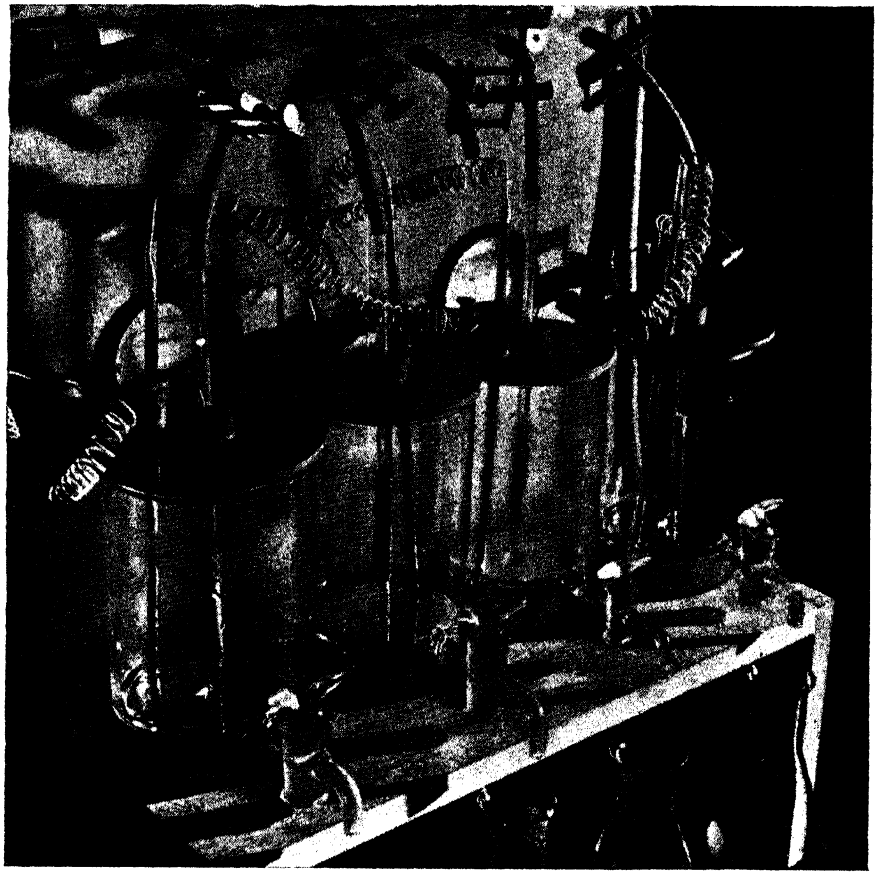
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The Society's Journal, which contains full reports of the Society's Meetings, together with general articles, book reviews, etc., normally issued weekly, is published fortnightly in present circumstances. It is posted free to Fellows.

All communications for the Society should be addressed to THE SECRETARY, ROYAL SOCIETY OF ARTS, 6-8 JOHN ADAM STREET, ADELPHI, LONDON, W.C.2. *Telephone Number :* Temple Bar 8274. *Telegrams :* Praxiteles, Rand, London.



Close Check

In recent years the use of alloy steels — those containing other metals, such as manganese, molybdenum and tungsten — has increased rapidly. Very small alterations in the composition of alloy steels may have a big effect on their properties. It is therefore necessary to be able to trace small quantities of non-ferrous metals in large quantities of steel. The chemist does this by using the electrolytic separator shown above. It consists of a number of glass vessels containing mercury and provided with electrodes or conductors through which an electric current can be passed. The metal to be analysed is dissolved in a liquid and placed in the glass vessels along with the mercury. An electric current is then passed through it. The iron in the steel alloy settles on the mercury. The remaining solution, which contains the other metals, is drawn off through the glass taps to be analysed in the ordinary way. The electrolytic separator enables the metallurgical chemist to trace small quantities of such metals as aluminium and vanadium, which are almost impossible to detect in any other way. It is part of the equipment which enables the British chemical industry to maintain the efficiency of its service to the community.

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4739 *FRIDAY, MARCH 28th,* 1947 Vol. xcv

CANCELLATION OF MEETING

It has unfortunately been found necessary, owing to the ill health of the lecturer, to cancel the meeting of the India and Burma Section arranged for Thursday, April 17th, at which Mr. Hugh G. Rawlinson, C.I.E., M.A., was to have read a paper on "The Influence of India upon European Culture".

MEETINGS OF THE SOCIETY TO THE END OF SESSION

Ordinary Meetings

WEDNESDAY, APRIL 16TH, at 5 p.m.—"ECONOMIC RECONSTRUCTION"—(vi) "PRODUCTION". By the Right Hon. Oliver Lyttelton, D.S.O., M.C., M.P. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Society, will preside.

WEDNESDAY, APRIL 23RD, at 5 p.m.—"ELECTRICITY IN THE HOME". By Miss Caroline Haslett, C.B.E., COMP.I.E.E., Director, Electrical Association for Women. H. T. N. Gaitskell, C.B.E., M.P., Parliamentary Secretary to the Ministry of Fuel and Power, will preside.

WEDNESDAY, APRIL 30TH, at 5 p.m.—"ECONOMIC RECONSTRUCTION"—(vii) "DISTRIBUTION". By E. J. B. Lloyd, B.A., LL.B., Director and Secretary, Lewis's Investment Trust, Ltd. The Right Hon. Lord Woolton, P.C., C.H., will preside.

WEDNESDAY, MAY 7TH, at 5 p.m.—"GAS IN THE HOME". By Mrs. G. E. Abbott, Organising Secretary, Women's Gas Council.

WEDNESDAY, MAY 14TH, at 5 p.m.—"ECONOMIC RECONSTRUCTION"—(viii) "BRITAIN'S ECONOMIC FUTURE". By Alfred C. Bossom, F.R.I.B.A., M.P. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Society, will preside.

WEDNESDAY, MAY 21ST, at 5 p.m. (*Selwyn Brinton Lecture*).—"INTERNATIONAL GOTHIC AND THE ITALIAN RENAISSANCE". By Sir Kenneth Clark, K.C.B., Slade Professor of Fine Art, University of Oxford. (Illustrated by lantern slides).

WEDNESDAY, MAY 28TH, at 5 p.m. (*Trueman Wood Lecture*).—"MODERN ASTRONOMICAL INSTRUMENTS". By Sir H. Spencer Jones, M.A., SC.D., F.R.S., Astronomer-Royal. (Illustrated by lantern slides).

Dominions and Colonies Section

TUESDAY, APRIL 15TH, at 2.30 p.m.—"SOCIAL WELFARE IN THE WEST INDIES".

By T. S. Simey, Professor of Social Science in the University of Liverpool. A. J. Wakefield, C.M.G., B.SC., Inspector-General of Agriculture and Agricultural Adviser to the Comptroller for Development and Welfare in the West Indies, will preside.

TUESDAY, MAY 20TH, at 2.30 p.m.—"THE DEVELOPMENT OF AUSTRALIAN ART". By Peter Bellew.

CANTOR LECTURES

MONDAYS, MAY 5TH, 12TH and 19TH, at 5 p.m.—"RECENT DEVELOPMENTS IN THE APPLICATION OF PHOTOGRAPHY". By D. A. Spencer, PH.D., D.I.C., F.R.I.C., HON.F.R.P.S., Technical Adviser, Kodak, Ltd.

MEETING OF COUNCIL

A meeting of the Council was held on Monday, March 10th, at 2.30 p.m. Present: Sir Edward Crowe (in the Chair); Mr. F. H. Andrews; Mr. A. C. Bossom; Sir Frank Brown; Major W. H. Cadman; Mr. E. W. Goodale; Sir William Halcrow; Mr. Basil Ionides; Sir Harry Lindsay; Mr. J. A. Milne; Mr. J. W. Ramsbottom; Mr. E. M. Rich; Mr. A. R. N. Roberts; Mr. E. Munro Runtz; Captain A. H. Ryley; Lord Samuel; Mr. William Will and Miss Anna Zinkeisen; with Mr. K. W. Luckhurst (Secretary) and Mr. C. Burns (Assistant Secretary).

The following were duly elected Fellows of the Society:

Banks, Air-Commodore Francis Rodwell, C.B., O.B.E., Walton-on-Thames, Surrey.
Barlow, Henry Arthur Northey, O.B.E., I.C.S., Bridgwater, Shropshire.
Blackwood, Brian George William, Reigate, Surrey.
Branders, Philippus Daniel Richard, Orange Free State, South Africa.
Carter, George Bertram, F.R.I.B.A., London.
Challenger, Professor Frederick, PH.D., D.SC., Leeds.
Daglish, Squadron-Leader Eric Fitch, PH.D., Aylesbury, Bucks.
Feather, Professor Norman, PH.D., F.R.S., Edinburgh.
Foulds, Robinson Percy, M.SC., Carnforth, Lancs.
Gamblin, William George James, Bradmore, Notts.
Gardiner, Reginald Thomas, M.B.E., Punjab, India.
Gharpure, Bhaskar Vishvanath, Bombay, India.
Hale, Thomas Harrold, Tividale, Staffs.
Hampson, Charles Phillips, J.P., Eccles, Lancs.
Henniker-Gotley, Reverend George, M.A., Lewes, Sussex.
Hey, Charles Matthews, Preston, Lancs.
Hogg, Stanley Alfred, London.
Hughes, Patrick Lawrence, Manchester.
Jackson, William Theodore, M.B.E., Orpington, Kent.
Krishnamoorthy, Venkatachala, M.SC., Madras, India.
Littler, Herbert Arthur, Winsford, Cheshire.
Lonsdale-Hands, Richard, London.
Myerscough, Edward Leslie, Terrington, York.
Neale, Cecil Kenneth, Harrow, Middx.
Nicoll, Gordon, R.I., West Byfleet, Surrey.
Pereira, Cajetan Francis, Secunderabad, India.
Pereira, Miss Lily, Secunderabad, India.

Prideaux-Brune, Sir Humphrey Ingelram, K.B.E., C.M.G., Edinburgh.
Raisman, Sir Jeremy, G.C.I.E., K.C.S.I., London.
Srivastava, H. K., M.A., Cawnpore, India.
Sykes, Mrs. Winifred, London.
Symes, Arthur John, London.
Ward-Jackson, Cyril Henry, London.
Watson, John Robson, London.
Wood, Kenneth Wilson, Southport, Lancs.
Yelf, Francis William, London.

The Council discussed correspondence which had been exchanged, since the last meeting, with the President of the Board of Trade on the subject of the proposed International Exhibition, and decided to arrange an interview of the Society's Committee with the Parliamentary Secretary, Department of Overseas Trade, as suggested by Sir Stafford Cripps.

It was reported that 18,249 entries had been received for the Society's Spring Examinations.

Further consideration was given to the award of the Albert Medal for 1947.

A quantity of formal and official business was transacted.

THE ALBERT MEDAL

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1947. They therefore invite Fellows of the Society to forward to the Secretary the names of such men of high distinction as they may think worthy of this honour. These names should reach the Secretary not later than Saturday, April 5th. The medal was struck to reward "distinguished merit in promoting the Arts, Manufactures and Commerce". A list of previous recipients appeared in the *Journal* of March 14th, 1947.

THE GAS TURBINE

WITH SPECIAL REFERENCE TO INDUSTRIAL APPLICATIONS

By Sir CLAUDE GIBB, C.B.E., M.E., F.R.S., *Chairman and Managing Director*, and A. T. BOWDEN, PH.D., B.SC., *Chief Research Engineer, of Messrs. C. A. Parsons & Co., Ltd.*

Eighth Ordinary Meeting, Wednesday, January 22nd, 1947

Rear-Admiral (E) the Hon. D. C. MAXWELL, C.B.E., *in the Chair*

THE CHAIRMAN: May I first express my appreciation of the honour bestowed on myself and the Engineering Branch of the Navy in having been asked to take the Chair this evening. My first and pleasant duty is to introduce to you the authors of the paper, Sir Claude Gibb and Dr. A. T. Bowden. Sir Claude Gibb, is, as you know, Chairman and Managing Director of C. A. Parsons & Co., Ltd. He holds many other posts and fulfils many other duties—he is President of certain Institutions and a member of educational, engineering and administrative boards. During the 1914–18 war he was

a pilot in the Australian Air Force. During the last war he was very much concerned with the production of tanks at the Ministry of Supply, and was Chairman of the Tank Board; so that he probably played an even greater part in the winning of the last war than in the first.

Dr. Bowden was associated with the Ministry of Supply during the war; he joined C. A. Parsons & Co. after the war, where he is Chief Research Engineer.

The following paper was then read:

In opening the lecture we have the honour to present this evening, we would in the first place seek to forestall criticism of its very title by making it quite clear that we are aware of the strong urge from many quarters to discard "Gas Turbine" in favour of "Combustion Turbine" or similar term.

This purist reaction arises from the fact that in its reciprocating counterpart, a gas engine refers specifically to a prime mover actuated by a gaseous fuel, as distinct from the generic term internal combustion engine, which embraces all engines in which the working fluid, be it from solid, liquid or gaseous source, is produced internally. Accordingly, since a gas turbine may not in fact use gas, but oil or even coal, and produce its working fluid either internally or externally, a certain ambiguity with reciprocating internal combustion engine nomenclature may result. However, the meaning of the term "gas turbine" is well understood and is now strongly entrenched, so we propose to refer to it as such.

Having made our bow to the critics, we would seek to introduce our subject by giving a short and quite inadequate historical survey of the gradual development of the gas turbine. In common with the steam engine, the steam turbine and the internal combustion engine, its development has been a gradual process, awaiting but a combination of circumstances and the fine touch of the master, or the dour determination of the man who sees the light and refuses to accept defeat, to bring it from the realms of fancy or crude construction to the stage where it becomes a powerful influence in man's destiny.

Thus, Watt did not invent the steam engine—he invented the condensing steam engine; Stephenson did not invent the locomotive—he invented an efficient locomotive; Parsons did not invent the steam turbine—he invented the principle of multi-stage reaction as applied to the turbine. The road to Watt's engine, Stephenson's locomotive and Parsons' turbine, is strewn with ideas, with the wreckage of dashed hopes, and graced with a few monuments of "near misses".

So with the gas turbine. Ideas are born in Hero, Leonardo da Vinci and Branca. Cycles of operation are announced by Stirling, Ericsson, Joule and others, and the patents records from about 1790 onwards bear testimony to the wealth of thought given by the mechanically minded to the subject. Although a number of gas turbines were actually built and operated from the beginning of the present century, the first rational conception of a gas turbine as we to-day interpret the name, was placed on record by Sir Charles Parsons in his famous specification No. 6735 of 1884, wherein he describes the principles of the reaction steam turbine:

> "Motors according to my invention are applicable to a variety of purposes, and if such an apparatus be driven it becomes a pump and can be used for actuating a fluid column or producing pressure in a fluid. Such a fluid pressure producer can be combined with a multiple motor, according to my invention,

to obtain motive power from fuel or combustible gases of any kind. For this purpose I employ the pressure producer to force air or combustible gases into a furnace (into which there may or may not be introduced other fuel, liquid or solid). From the furnace the products of combustion can be led in a heated state to the multiple motor which they will actuate. Conveniently the pressure producer and multiple motor can be mounted on the same shaft, the former to be driven by the latter, but I do not confine myself to this arrangement of parts. In some cases I employ water or other fluid to cool the blades, either by conduction of heat through their roots or by other suitable arrangements to effect their protection".

This statement, made in April, 1884, foreshadowed the gas turbine in its modern form—an axial flow compressor (Parsons reversed axial flow reaction turbine) forcing compressed air through a combustion chamber into which fuel is introduced, and from which the resultant products of combustion are led to a turbine in which they expand and do useful work.

Nevertheless, Sir Charles did little at that time to put his conceptions into practice, and gas turbine developments from the beginning of the present century until about 1937 were largely the work of Continental engineers, who concentrated thought and effort on two principal types characterised by the manner in which the working medium is formed. In the first type, which we may term the explosion-type gas turbine, the combustion of the fuel takes place intermittently at constant volume as in a petrol engine, and the products of combustion are led in pulses through the turbine. In the second, combustion takes place at approximately constant pressure.

The first turbine working on the former principle, rated at 50 h.p., was constructed by Holzwarth in the works of Gebrüder Korting at Hanover in 1908. The second unit, designed to develop 1,000 h.p., was built by Brown Boveri and erected in their Mannheim works in the winter of 1910. Later, after a good deal of experimental work, the turbine was removed from Mannheim and re-erected in the works of Messrs. Thyssen at Mulheim in the Rhur. A third machine of 500 h.p. was built to the order of the German State Railways in 1920. Later, in 1925, a machine of 5,000 kW. was built for the Muldenstein power station. In 1928 Brown Boveri again took up the Holzwarth turbine and a number of units for various purposes were constructed.

It is probably fair to say that after more than forty years' development, the explosion type of gas turbine has proved indifferent in operation, and there is no doubt but that it is giving way to the theoretically less efficient but simpler constant-pressure cycle. It is therefore proposed to confine further discussions to this type of gas turbine, while making it quite clear that the explosion type is not dead, but is still in fact receiving a good deal of attention in one form or another. The work of Pescara, Sulzer Bros., and more lately Lutz in this direction deserves special mention.

Probably the first working gas turbine designed to operate on the constant-pressure cycle was that of the French engineers, MM. Armengaud and Lemale, constructed at the plant of the *Société des Turbomoteurs* in Paris in 1904. This was a 25 h.p. modified de Laval steam turbine with a 6 in. wheel running at 20,000 r.p.m. Petroleum in an atomised state was burned in a combustion chamber

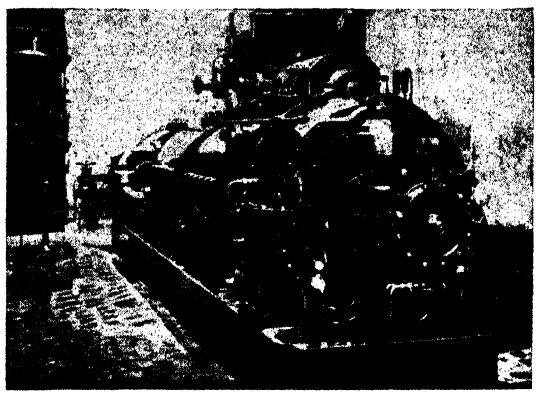
supplied with air from a Rateau centrifugal blower at 71 lb. pressure. The mixture was fired by a hot wire, and the products of combustion, after being cooled by a water spray, were expanded in a nozzle before acting on the blades.

A larger machine, comprising a two-row Curtis wheel, 37·4 in. in diameter, acted upon by the gases from 33 nozzles, was built in 1906 with an output of 300 b.h.p. at 4,250 r.p.m. A three-cylinder, 25-stage, centrifugal compressor of the Rateau type, built by Brown Boveri & Co., and coupled directly to the turbine, delivered air at 60 lb. absolute. The temperature was 840°F. at the inlet blading and 788°F. at the exhaust. Owing very largely to the low efficiency of the compressor the power developed by the turbine was hardly sufficient to drive it. Sir Dugald Clerk stated that the fuel consumption was 3·9 lb. of petrol per b.h.p. per hour! Photographs of the two machines described above are shown in Figs. 1 and 2.*

That concludes a very brief historical cross-section of the more important events



FIG. 1.—*The 30 h.p. experimental gas turbine of the* Société des Turbomoteurs



(Reproduced by courtesy of "Mechanical Handling")

FIG. 2.—*The 300 h.p. gas turbine of Armengaud and Lemale connected to the Rateau multicellular turbine compressor*

leading to modern gas turbine thought and developments. Serious consideration of the subject may be considered to have begun about 1935 or 1936 when, both on the Continent and in England, firms which had long been engaged in steam turbine design and construction began to consider seriously the production of the constant-pressure gas turbine. That is not to say that gas turbines had not been made in the interim. They were, in fact, made and successfully used, for example, in the Buchi system of supercharging and in connection with the Houdry process in oil-refining plants. But such units were more in the nature of auxiliaries designed to improve output, or to use a convenient source of otherwise waste energy. They were not competitors in the field of power generation. They did, however, provide most useful information regarding compressors and the behaviour of metals at temperatures of the order of 550°C.

The patents filed from 1937 onwards bear testimony to the thought given to the subject of the constant pressure cycle gas turbine. Undoubtedly the results of aero-dynamic research applied to compressor design and the developments in heat-

*Inst. Mech. Eng. Proc., 152, 1945, pp. 419–435.

resisting materials were largely instrumental in bringing about this renewed interest, since high working temperatures and efficient compression are the *sine qua non* of efficient gas turbine operation.

The waxing immediate pre-war interest in and developments of industrial gas turbines pale into insignificance, however, when compared with the meteoric developments which took place during the war in the application of the gas turbine to the jet propulsion of aircraft in this country and in Germany. These developments have been fully described in the technical press, and particularly by Air Commodore Whittle in his lecture to the Institution of Mechanical Engineers*, in the Wilbur Wright lecture delivered in America by Dr. Roxbee Cox† and in the symposium of papers delivered to the Institution of Mechanical Engineers by members of the Power Jets Research Team‡. Since our lecture this evening is devoted to industrial developments, we may only mention in passing the debt which post-war industry

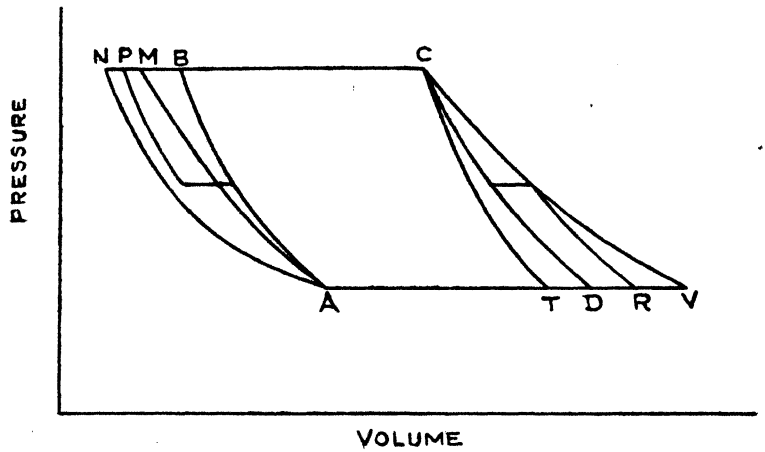


FIG. 3.—*P.V. diagram for constant pressure cycle*

owes to these intensive war-time efforts in the aircraft field, but we welcome the opportunity and privilege of paying tribute to Air Commodore Whittle for his genius and dogged perseverence, to Dr. Roxbee Cox and his associates at Power Jets, to the Mond Nickel Co., to Joseph Lucas, and to the Jet Engine Builders—all of whom have done so much to help industrial engineers to build on sure foundations.

Having dealt briefly with its historical development, we may now conveniently consider some of the technical problems associated with industrial gas turbine design and operation.

BASIC CYCLE OF OPERATION

The basic cycle of operations of the constant pressure type is that described by Joule in 1851 and shown in the pressure-volume diagram, Fig. 3. The working fluid, under initial pressure and volume conditions represented by A, is compressed

*Inst. Mech. Eng. Proc., 152, 1945, pp. 419-435
†Journal of the Aeronautical Sciences, February 13th, 1946.
‡Proc. Inst. Mech. Eng., 1945. Vol. 153. Emergency Issue 12.

polytropically to B. Adiabatic compression would have moved it to point N, isothermal to N, and stage intercooled to P. Heat is taken in ideally at constant pressure along BC, but in practice a pressure loss occurs in the combustion chamber. Expansion takes place polytropically to point D. Adiabatically it would have moved to T, isothermally to V, and with interstage reheating to point R. The working fluid then rejects its heat at constant pressure along DA. If the cycle is open, the heat is rejected to atmosphere and a fresh charge of working fluid inhaled at A. If, on the other hand, the cycle is closed, the heat rejected is given up to a cooling medium and the constantly-circulating charge is recompressed at A.

In either case, some of the heat remaining after expansion may usefully be taken up by the working medium through the intermediary of a heat exchanger, following compression to the point B, and prior to the heat addition by the fuel. Line diagrams

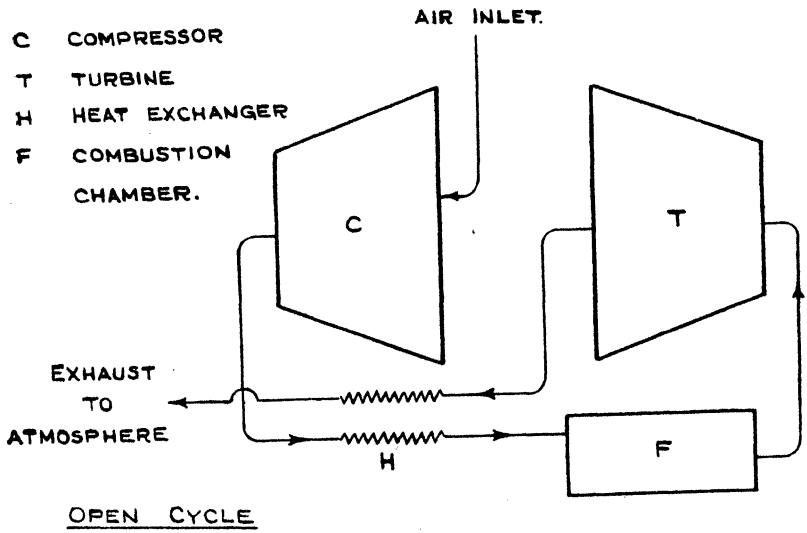


FIG. 4.—*Open cycle gas turbine*

for the system are shown in Figs. 4 and 5 relating to the open and closed cycles respectively, with air as the working fluid. Fig. 6 shows a descriptive sketch of an open cycle unit.

The cycle of operations outlined in the pressure-volume diagram, Fig. 3, transferred to the T.Ø. diagram (Fig. 7), forms a convenient basis for a study of some of the more important factors which govern the design of an efficient gas turbine. Referring to Fig. 7, the working fluid is compressed ideally adiabatically along AM or isothermally along AN. Uncooled compression will normally take place polytropically along AB; with multi-stage intercooled compression the stage point will move in steps from A to P. Heat is added ideally at constant pressure from B to C, followed ideally by adiabatic expansion along CT, or isothermal expansion along CV. In practice, where reheating is not employed during the expansion process, the state point will move polytropically to D, while with reheating it will move in steps to R.

At this point, representing exhaust conditions, the temperature is still high and it is mainly in its ability to utilize a proportion of the heat contained in the exhaust that it is possible, commercially, for the gas turbine to compete with the steam turbine or internal combustion reciprocating engine. In practice, therefore, a heat

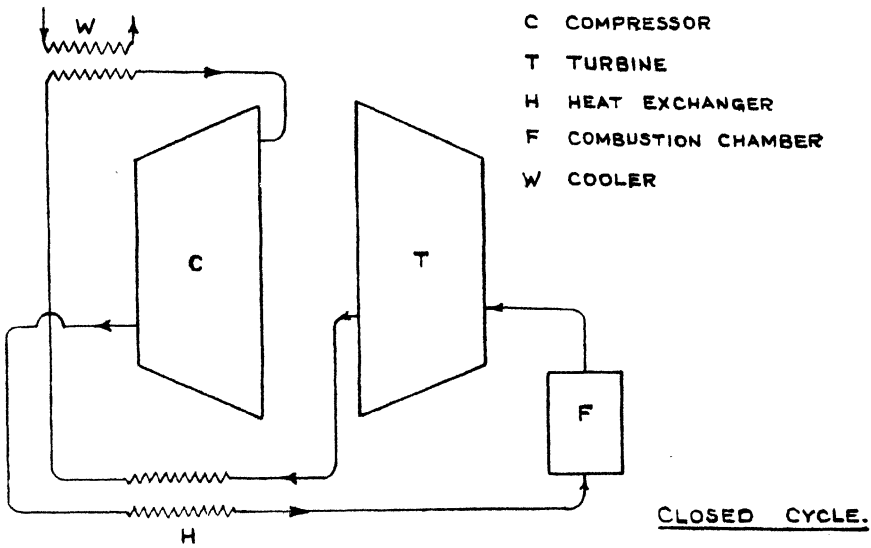


FIG. 5.—*Closed cycle gas turbine*

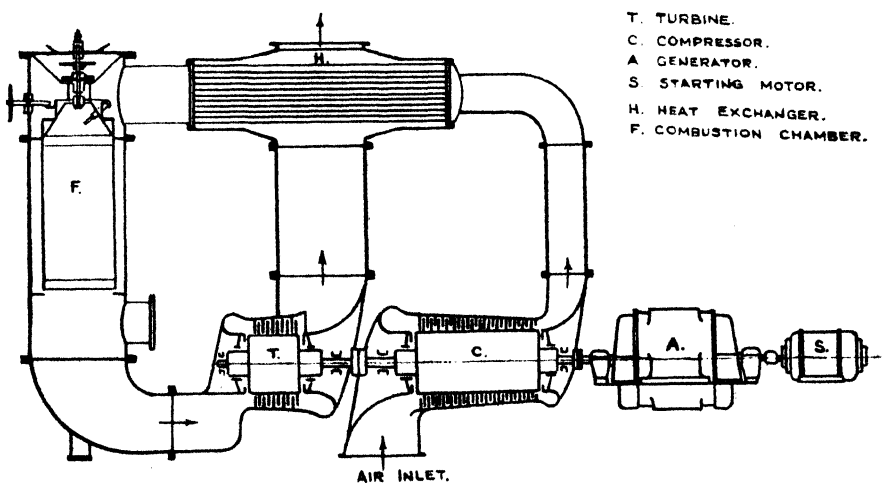


FIG. 6.—*Open cycle turbine unit*

exchanger, as indicated in the cycle diagrams (Figs. 4 and 5), transfers a portion of the exhaust heat at state point D to the air at state point B.

Considering now the simple cycle with uncooled compression, and without reheat, it is seen that ideally the net useful output is a function of the divergence of the constant pressure lines MC and AD, and is therefore for adiabatic compression

and expansion, given by the difference in length of the lines CT and AM. Practically with polytropic expansion, the nett output is given by the total heat difference $(H_c-H_d)-(H_b-H_a)$, and so it will be seen that at a temperature L, such that after polytropic expansion to K, the total heat difference (H_l-H_k) is equal to (H_b-H_a),

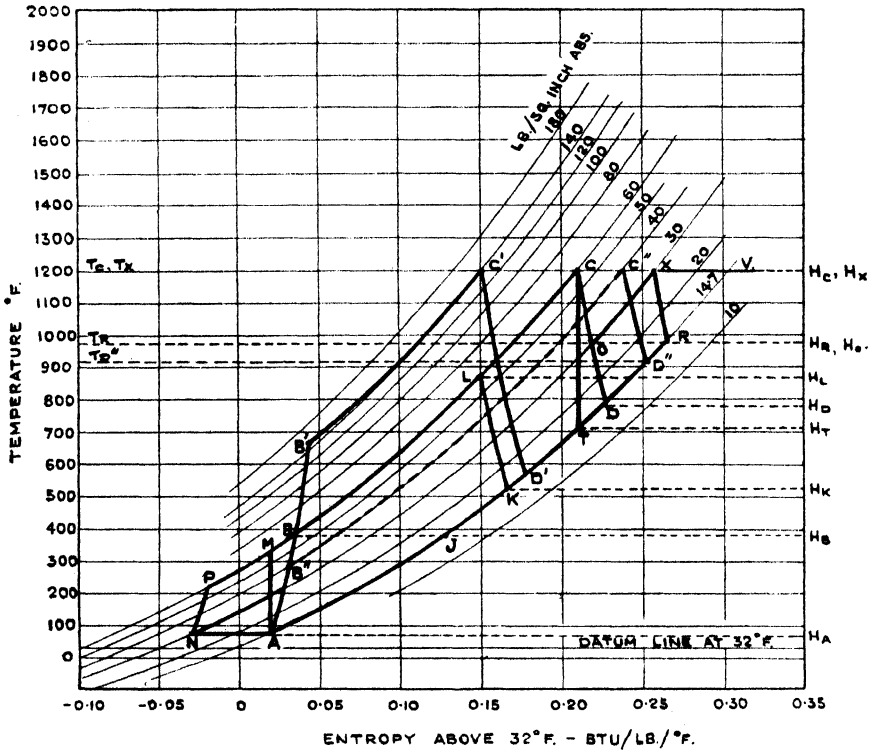


FIG. 7

the unit will be just self-supporting, but will give no useful output. The efficiency of the cycle, which is equal to $\frac{\text{Nett work}}{\text{Heat supplied}}$ is represented in the H.T.Ø. diagram by $\frac{(H_c-H_d)-(H_b-H_a)}{(H_c-H_b)}$. The negative work represented by (H_b-H_a), has of itself only a moderate effect on the efficiency, since for a given maximum temperature, heat not added by the compressor must be added by the fuel. It does, however, have a most important effect on the work factor, defined as total nett output divided by the total work done, and upon the specific output, that is, the nett work per unit quantity of circulating working fluid.

THE COMPRESSOR

It was just on this point that early inventors were at such a disadvantage, since, with the low working temperatures possible with the materials then available, a high compressor efficiency was not only desirable but necessary, even for the unit to be

self-supporting. Apart from the development of heat-resisting materials, the one factor which has contributed more than any other to the present position and future possibilities of the gas turbine in industry is the development of the high-efficiency compressor and particularly the multi-stage axial flow compressor.

Early developments are centred round the work of Sir Charles Parsons, whose Patent No. 6375 previously referred to was entitled "Improvements in Rotary Motors actuated by Elastic Fluid Pressure and applicable also as Pumps". A later patent, No. 3060, of the year 1901, was entitled "Improvements in Compressors and Pumps of the Turbine Type". He states therein:

> "My invention consists in a compressor or pump of the turbine type operating by the motion of sets of movable vanes or blades between sets of fixed blades, the movable blades being more widely spaced than in my steam turbines, and

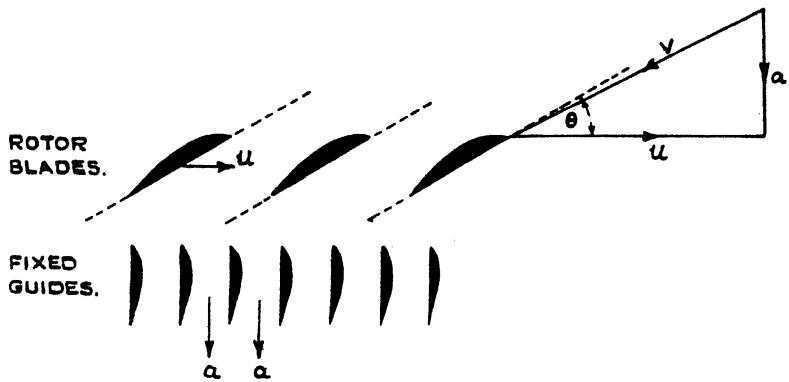


FIG. 8.—*Diagram of one stage of the Parsons' parallel flow compressor blading, patented in* 1901

> constructed with curved surfaces on the delivery side and set at a suitable angle to the axis of rotation. The fixed blades may have a similar configuration and be similarly arranged on the containing casing at any suitable angle, but sometimes may be placed substantially parallel to the axis of rotation".

Fig. 8 shows the blading layout used in Sir Charles' first commercial axial compressor, built in 1901, and Fig. 9 shows a photograph of the same compressor. The duty was 3,000 cu. ft. of free air per minute at a delivery pressure of 1·75 lb. per sq. in. The speed was 4,000 r.p.m., and 19 pressure stages were employed. The unit was supplied to Messrs. Cookson & Sons, Howdon-on-Tyne.

Developments continued at Heaton Works for some years, and Figs. 10 and 11 show the layout and operating characteristics respectively of a unit built in 1907 for the Hanyang Iron and Steel Works, China. This particular unit delivered 28,200 cu. ft. of free air per minute at a pressure of 11·75 lb. per sq. in. As will be seen, the efficiency at the rated duty of between 55 and 60 per cent. is, in the light of our present knowledge, low—too low to be of any practical use in a gas turbine. Very little of the theory of the flow of fluids was known in those days, and as mentioned previously, it is just this knowledge, obtained largely in the last thirty years, that makes modern efficient designs possible. It is not surprising therefore

that about 1909 the axial flow compressor gave way to the then more efficient centrifugal type, developed largely by Rateau.

The pressure/volume and efficiency characteristics of a typical modern multi-stage industrial type axial flow compressor, shown in Fig. 12, make an interesting comparison with that of the Parsons compressor in Fig. 11, and clearly indicate the advances that have been made in compressor design.

The maximum adiabatic efficiency, it will be seen, is now of the order of 84 per cent., but the pressure/volume lines are very much steeper, and greater care is required in setting the work line to prevent surging and to provide easy starting.

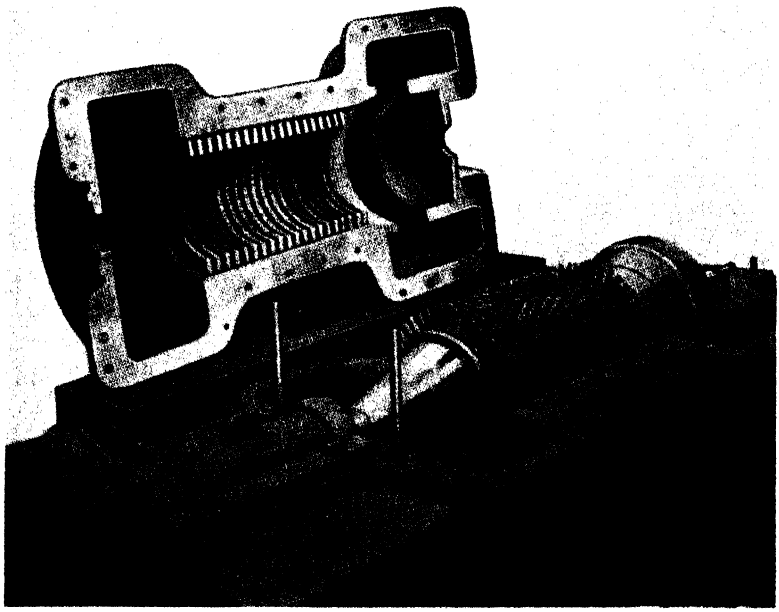


FIG. 9.—*The first commercial axial-flow compressor (installed* 1909)

For industrial designs which are required to run for long periods between inspection and overhaul, design-point efficiency of the order of 84 per cent. should be readily obtainable.

For comparison the characteristics of a modern centrifugal compressor are shown in Fig. 13. It will be noted that although the maximum efficiency is lower, the pressure/volume curves are, in general, flatter. In certain cases, depending on the output, compression ratio and working temperature selected, it may be possible to use this relatively simpler type with advantage, since the work line as shown in Figs. 14 and 15 may, having regard to surging difficulties in the axial type, be designed to run more closely to the high efficiency region of the centrifugal compressor. The importance of the compressor efficiency, referred to above, is clearly

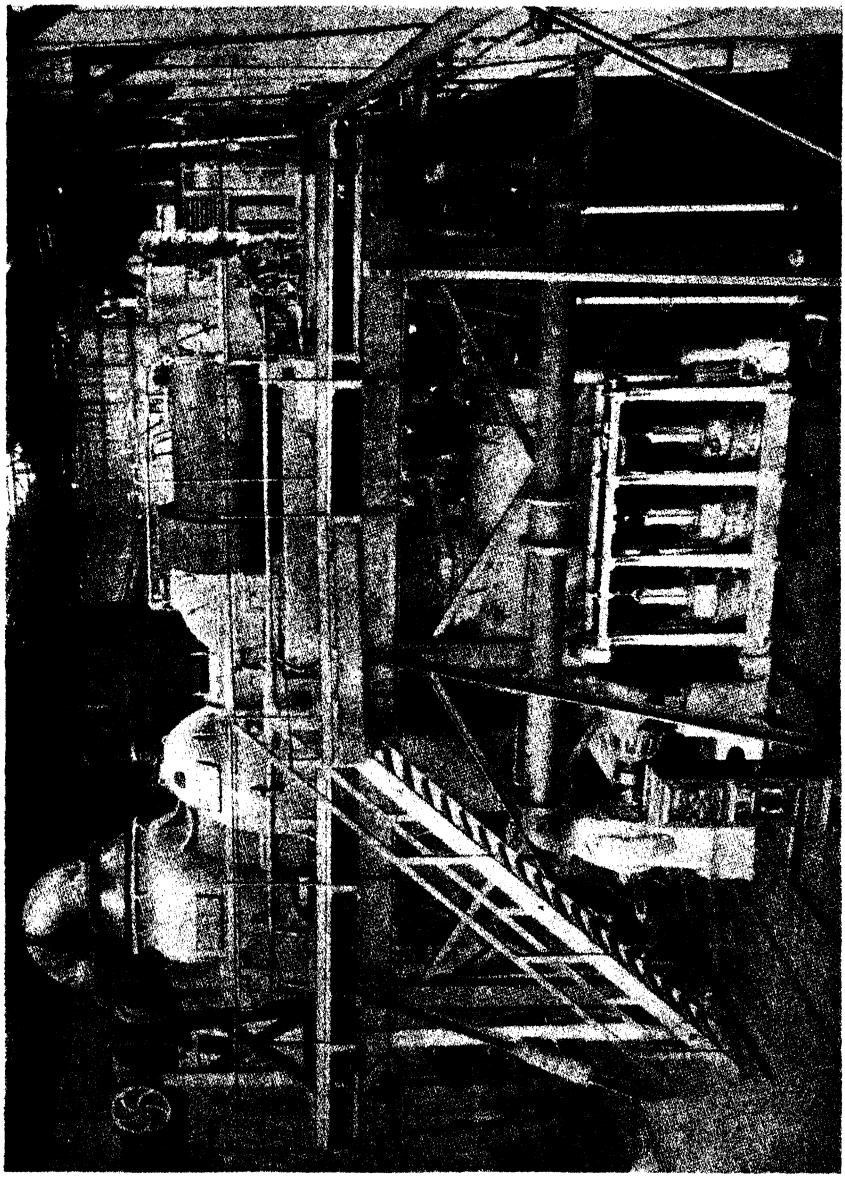


FIG. 10.—*A Parsons' turbo-compressor in the Test House at Heaton Works* (1907)

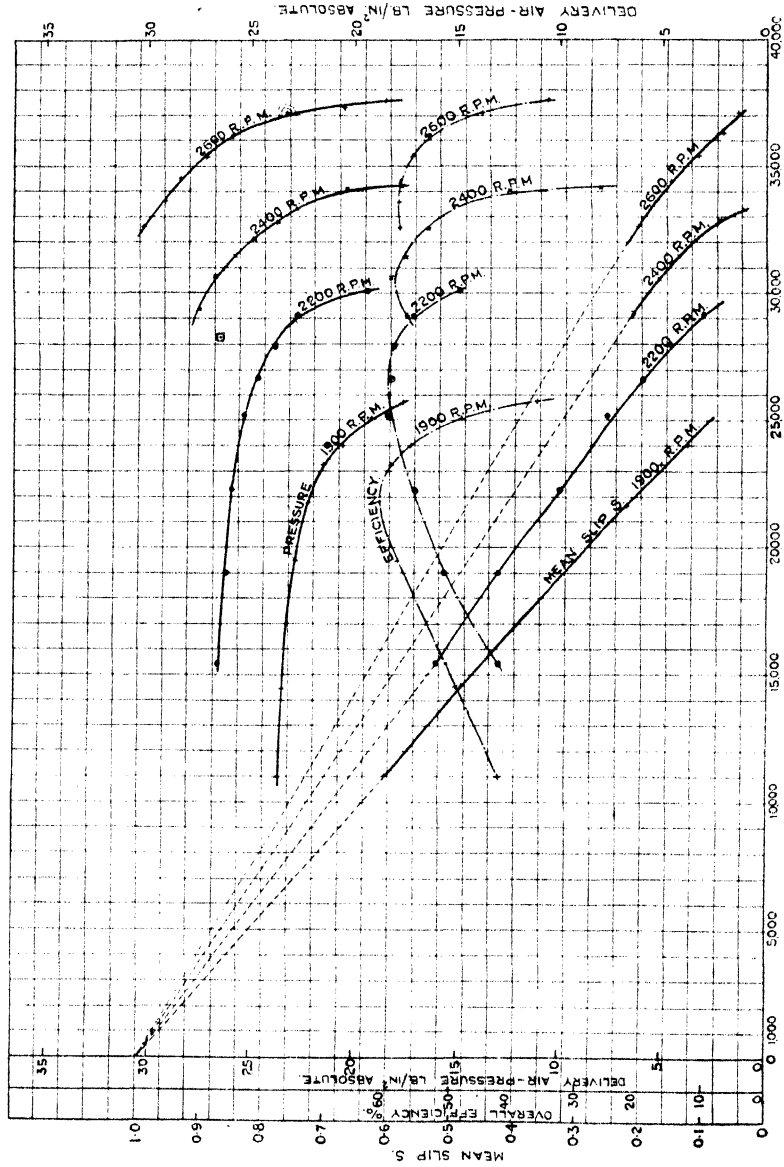
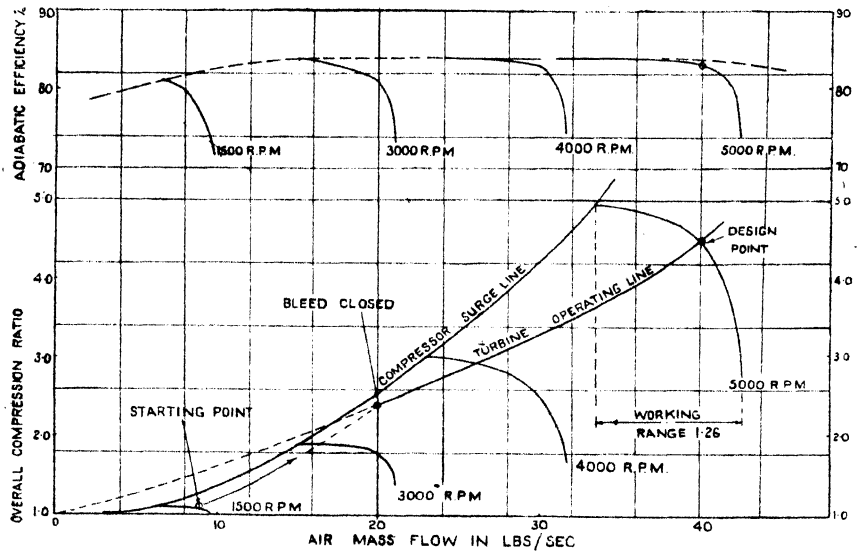
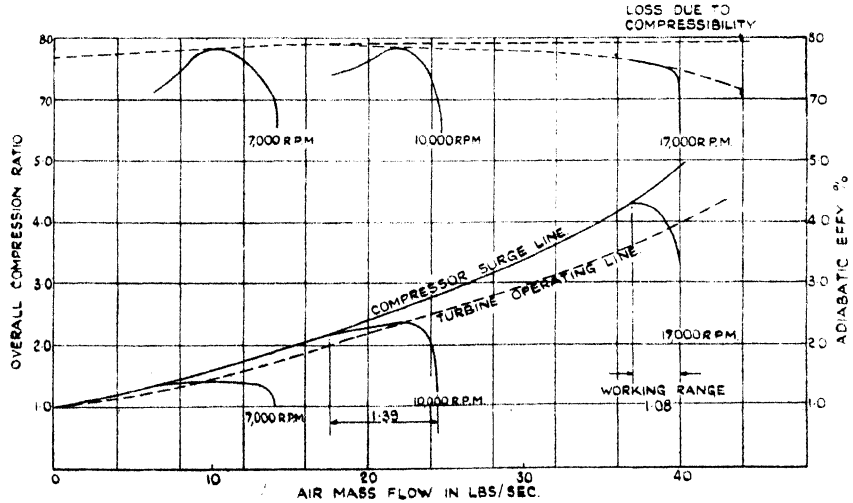


FIG. 11.—*Diagram of test data obtained with the compressor illustrated in Fig.* 10



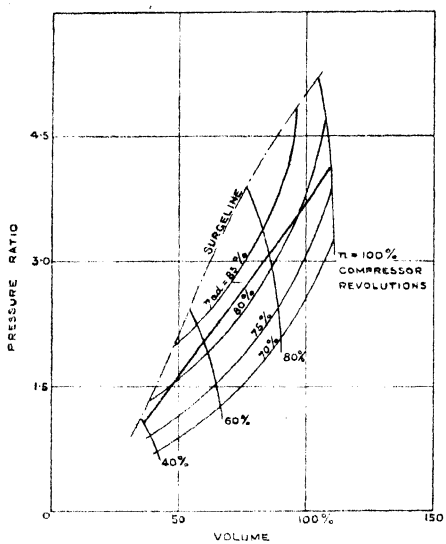
TYPICAL LOW STAGGER AXIAL COMPRESSOR CHARACTERISTICS
DESIGNED FOR 4·5 : 1 COMPRESSION RATIO & 40 LBS/SEC AIR FLOW

FIG. 12.—*Characteristic of a typical modern axial flow compressor*



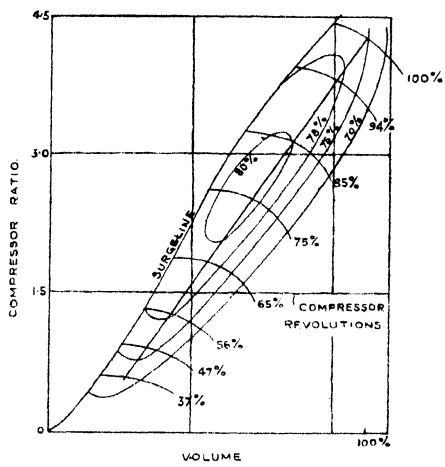
SINGLE-STAGE CENTRIFUGAL COMPRESSOR CHARACTERISTIC
DESIGNED FOR 4:1 COMPRESSION RATIO & 40 LBS/SEC. AIR FLOW.

FIG. 13.—*Characteristic of a single stage centrifugal compressor*



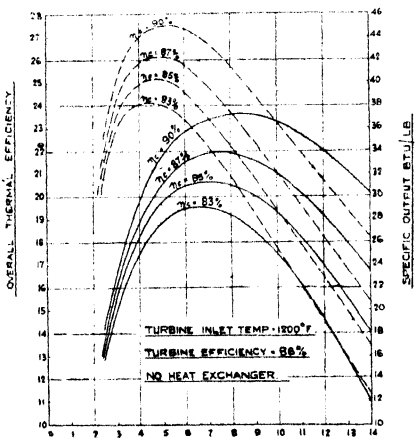
AXIAL FLOW COMPRESSOR CHARACTERISTICS IN RELATION TO WORKLINE

FIG. 14



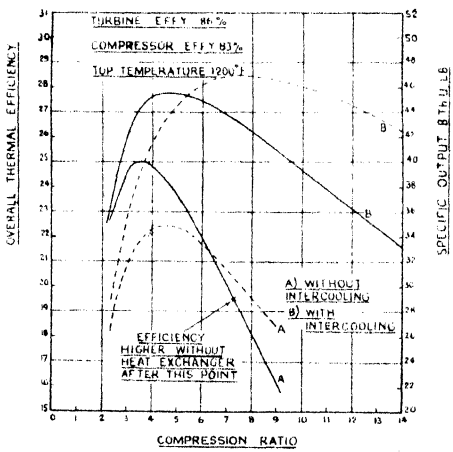
CENTRIFUGAL COMPRESSOR CHARACTERISTICS IN RELATION TO WORKLINE

FIG. 15



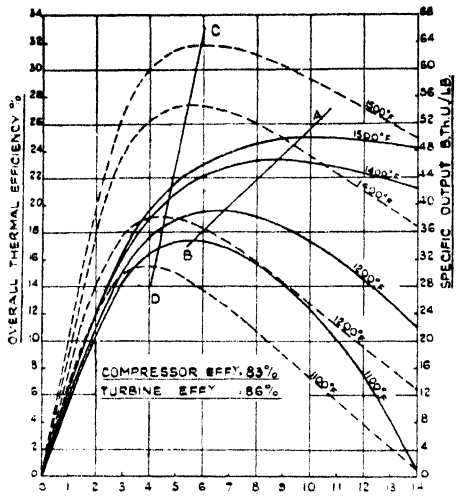
VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPR. RATIO FOR DIFFERENT COMPRESSOR EFFICIENCIES (NO HEAT EXCHANGER)

FIG. 16



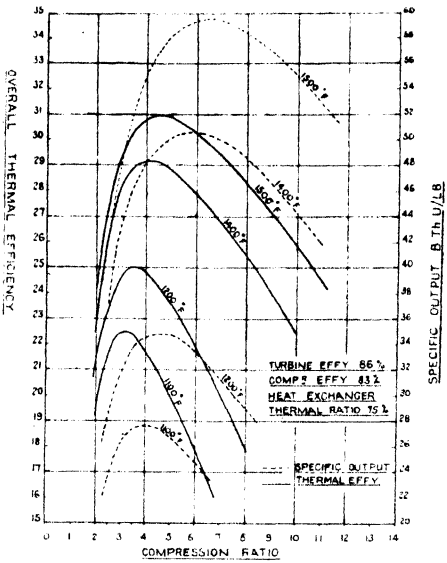
EFFECT OF ONE STAGE OF INTERCOOLING ON OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) OF A SIMPLE CYCLE EMPLOYING A 75% EFFECTIVE HEAT EXCHANGER

FIG. 17



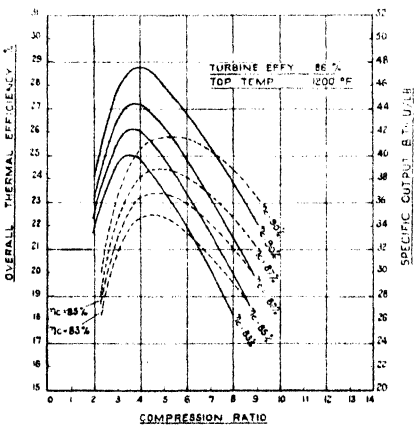
VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPRESSION RATIO FOR DIFFERENT TOP TEMPERATURES. (NO HEAT EXCHANGER)

FIG. 18



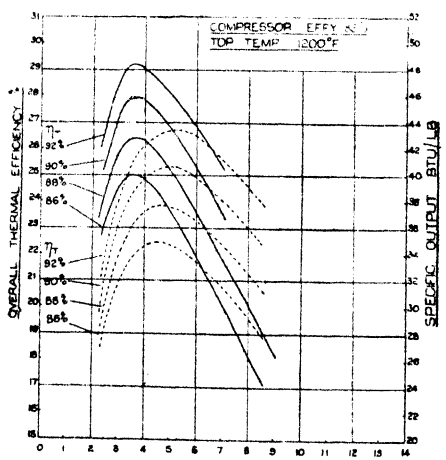
VARIATION OF OVERALL THERMAL EFFICIENCY AND SPECIFIC OUTPUT WITH COMPN RATIO FOR DIFFERENT TOP TEMPERATURES (WITH 75% EFFECTIVE HEAT EXCHANGER)

FIG. 19A



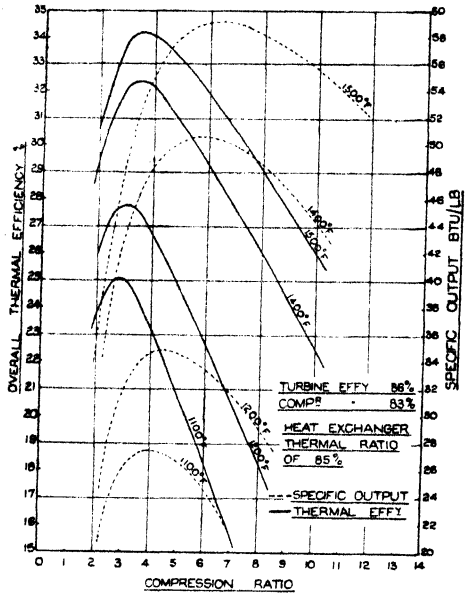
VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPRESSION RATIO FOR DIFFERENT COMPRESSOR EFFICIENCIES (WITH HEAT EXCHANGER OF 75% EFFECTIVENESS)

FIG. 19B



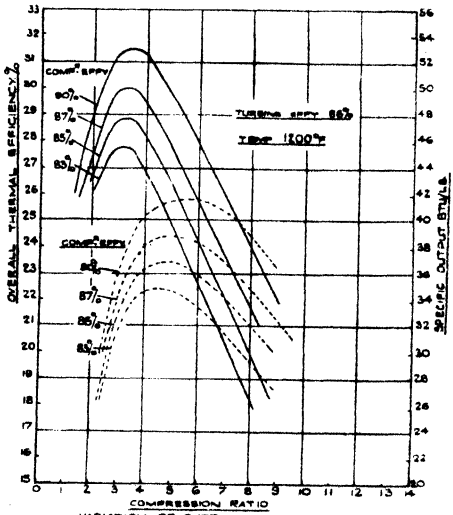
VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPRESSION RATIO FOR DIFFERENT TURBINE EFFICIENCIES (WITH HEAT EXCHANGER OF 75% EFFECTIVENESS)

FIG. 19C



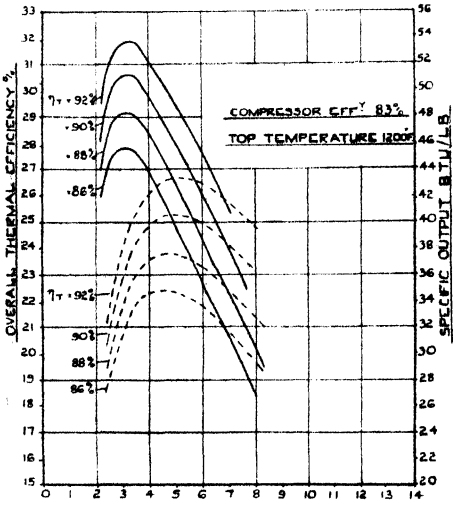
VARIATION OF OVERALL THERMAL EFFICIENCY AND SPECIFIC OUTPUT WITH COMPRESSION RATIO FOR DIFFERENT TOP TEMPERATURES (WITH 85% EFFECTIVE HEAT EXCHANGER)

FIG. 20A



VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPRESSION RATIO FOR DIFFERENT COMPRESSOR EFFICIENCIES (WITH HEAT EXCHANGER OF 85% EFFECTIVENESS)

FIG. 20B



VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPRESSION RATIO FOR DIFFERENT TURBINE EFFICIENCIES. (85% EFFECTIVE HEAT EXCHANGER)

FIG. 20C

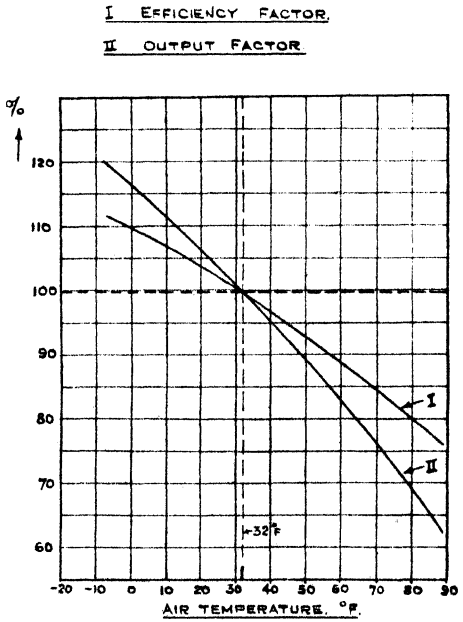


FIG. 21—*Effect of air inlet temperature on efficiency and output.*

indicated in Fig. 16, which shows for a simple cycle with a working temperature of 1,200°F. the effect on overall efficiency of varying values of compressor efficiency. The failures of the early gas turbines working with low compressor efficiencies are explained. It will be noted that the returns by way of increased overall efficiency and specific output, for each 1 per cent. increase in compressor efficiency, increase with increase in compression ratio, and vary roughly from a $2\frac{1}{2}$ per cent. return at the optimum to over 8 per cent. at a compression ratio of the order of 12 to 1.

For large outputs it is necessary, from considerations of the work factor and the

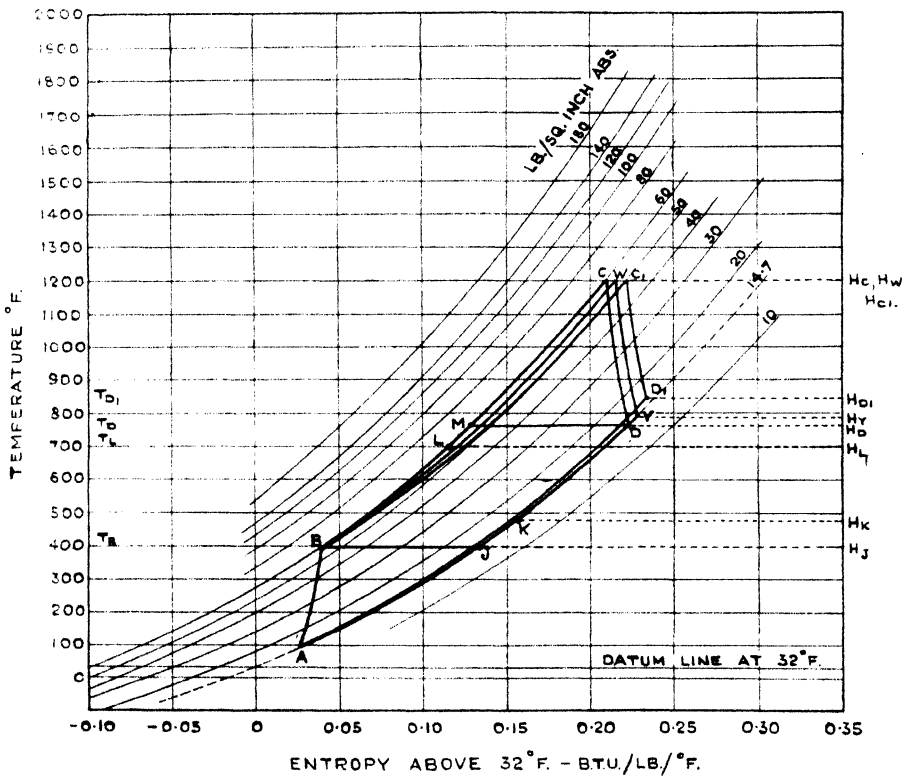


FIG. 22

specific output, to employ stage compression with inter-stage cooling. The effect of such may be gauged from Fig. 17, which shows an improvement in specific output of the order of 33 per cent. for one stage of intercooling, in a cycle embracing a 75 per cent. thermal ratio heat exchanger. A cooler loss equivalent to 2 per cent. of the maximum pressure has been allowed in drawing up the curves. In a regenerative cycle, intercooling improves the efficiency, as is evident from Fig. 17, since the lower air temperature allows of more heat transfer in the heat exchanger.

Referring again to the H.T.Ø. diagram (Fig. 7) it will be clear that, for a maximum temperature T_c, a large number of compression ratios and hence corresponding expansion ratios may be selected, for instance ABCD, AB'C'D' and AB''C''D''. Obviously there is an optimum for selected conditions of temperature, component

efficiencies, pressure drop in the system, and heat exchanger thermal ratio, and this point is well brought out in Fig. 18, which shows a series of efficiency and specific output curves at varying temperatures for a simple cycle without regenerator, plotted on a base of compression ratio. These serve to emphasise the point discussed above and also bring out the important fact that efficiency and specific output do not march hand in hand. The compression ratio selected will, therefore, in general be a compromise between that giving maximum efficiency and that giving maximum specific output.

The compression ratio for optimum efficiency in a non-regenerative cycle is lowered when a heat exchanger is introduced, as may be noted by reference to Figs. 18, 19 and 20. The high exhaust temperature T_d'' (Fig. 7), corresponding to the low compression ratio represented by A_b'' is no longer a deterrent to efficiency, as a considerable part of the exhaust heat is now recoverable. At the same time, a compression ratio higher than that for optimum efficiency will give a greater specific output; so that, as already noted for the non-regenerative cycle, a compromise must in general be effected, taking into consideration the size of plant and the relative importance of size and efficiency.

Effect of Inlet Air Temperature

As will readily be seen from the T.Ø. diagram, the work of compression increases directly with increase in inlet air temperature. So too, of course, does the temperature at the end of compression, and accordingly the efficiency of the heat exchanger is reduced, in that for a given exhaust temperature there is less heat given up to the air.

The effect of increasing air inlet temperatures on efficiency, specific output, and total nett output, is very considerable, as may be noted from Fig. 21, which relates to a unit with a maximum operating temperature of 1,200°F.

For marine applications where very considerable temperature variations are likely to be experienced, it is of the utmost importance to take the fullest account in design of the effects produced on output and efficiency.

Combustion

Referring to the T.Ø. diagram, reproduced in Fig. 22 for the sake of clarity, let us now consider the combustion problem. Ideally, combustion takes place at constant pressure. In practice we must accept a pressure drop larger or smaller according to the design adopted.

For a given maximum temperature T_c a loss in pressure during combustion, together with pipe losses, results in the expansion taking place from a lower pressure point W to a point Y giving $(H_c - H_y)$ as the work done, and a loss of work equal to $(H_y - H_d)$ compared with that obtainable with no pressure loss. This loss need not be so serious in industrial combustion chambers as in aircraft types, where space restrictions entail a very high rate of heat liberation, of the order of 2×10^6 B.Th.U's per cubic foot per hour per atmosphere, with a pressure loss $\frac{\Delta P}{P}$ varying from 2 to 10 per cent. Corresponding industrial combustion chamber figures may be of the order of $0{\cdot}35$ to $0{\cdot}5 \times 10^6$ B.Th.U's with a pressure loss of $0{\cdot}5$ to 2 per cent.

It is difficult at this stage of development to predict what ultimate form the combustion chamber for large plants will take. It is doubtful, however, if the long life demanded can be met by the sole use of metals, and since space or volume need not be restricted to the same extent as in aircraft designs, there is every reason to believe that the use of firebrick lined combustion chambers will be found practical and economical. Such materials as chrome oxide, sintered alumina and carborundum can, with advantage, be used in relatively high heat release designs, while good quality firebrick will probably suffice for the less highly rated units.

The basis of a number of high heat release designs may be simply explained by reference to Fig. 23. The fuel under pressure is delivered through a burner A, conveniently of the spill type, in a finely atomised form. Primary combustion air enters through a swirler B, which, *inter alia*, ensures a return current of air, through the vortex produced as indicated by the arrows, which maintains flame stability.

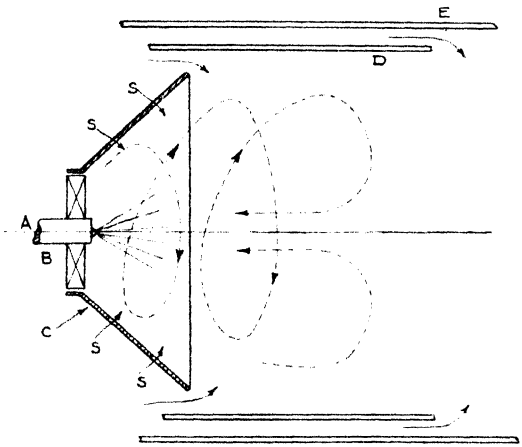


FIG. 23.—*Diagram showing principle of a high heat release combustion chamber*

Secondary air is introduced at S through the cone C and between the cone and the flame tube D. The temperature of combustion being greatly in excess of that acceptable to the working materials, a large proportion of diluting air is necessary. This air is introduced between the flame tube and outer shell E after combustion is complete, and apart from acting as a necessary diluent, serves to keep both shell and flame tube cool. Fine atomisation, careful metering of primary, secondary and tertiary air, and uniformity of air distribution, are the fundamentals of successful combustion chamber design, but no one who had had experience of their design and operation would seek to minimise the work that is necessary with any selected design, to obtain continuously successful combustion. It is without doubt the most difficult component in any industrial design, is still largely an art, and still not capable of exact solution. The principles outlined above have been followed in the Parsons design shown in section in Fig. 24.

Air from the heat exchanger enters the branch B and by controllable metering slots P is led in part through the swirler, surrounding the burner C.

Secondary air again metered by slots D, is directed between the cone E and the

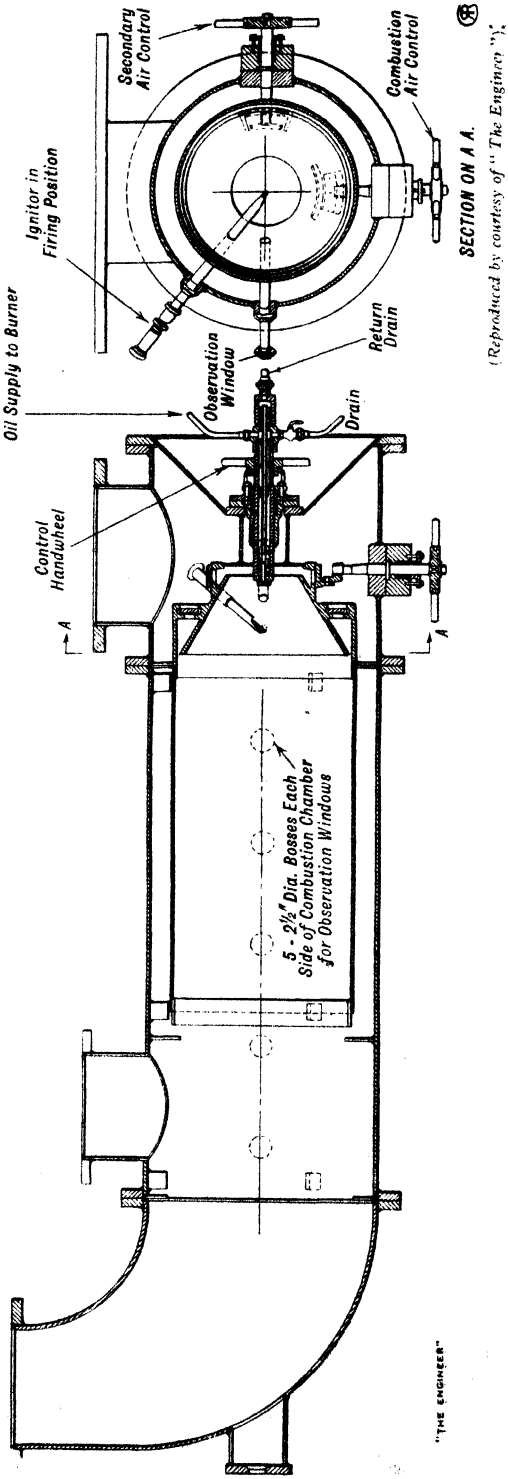


FIG. 24.—*Section through combustion chamber*

inner or flame tube F. Tertiary or diluent air, led between the flame tube and outer shell G, serves to keep both cool.

By careful control of primary and secondary air, the flame may be kept clear of the cone body, thus ensuring long life, and combustion may be completed in a short distance, allowing the early introduction of dilution air and consequent reduction in overall length of combustion chamber.

Fuel supplied by independently driven gear pumps is fed through a thermostatically controlled heater to a burner of the spill type, whereby the variation of fuel quantity corresponding to load requirements is obtained by varying the spill pressure.

Operating Temperatures

And now, having followed the cycle to the stage where the working medium leaves the combustion chamber, we come to one of the most important questions in industrial gas turbine design: "What is the maximum permissible working temperature?" Considering the matter in the first instance thermodynamically, it was noted previously (Reference Fig. 7) that when for a given compression ratio the temperature at L is such that $(H_l - H_k)$ is equal to $(H_b - H_a)$ the unit is just self-supporting. With increasing temperature both the specific output and efficiency are increased although in a somewhat complicated manner, as is evident from a study of Fig. 18, in which the curves have been drawn on a basis of inlet conditions of 75°F. and 14·7 lb. per sq. in. A pressure loss equivalent to 3 per cent. of the maximum pressure has been allowed for.

It will be noted that for a given compression ratio in a non-regenerative cycle, an increase in temperature results in a decreasing rate of gain in efficiency, whereas the rate of increase in specific output remains sensibly constant. For a given temperature the optimum compression ratio for maximum efficiency exceeds that for maximum specific output, and the optimum for either increases with increasing temperature but at a greater rate for the former than for the latter. This point is well brought out by the optimum efficiency and specific output lines AB and CD. The gain of efficiency with increasing temperature diminishes with decreasing compression ratio, whereas the corresponding gain in specific output remains sensibly constant. Provided the compression ratio is properly chosen, there is thermodynamically no limit to the temperature (the working medium remaining stable) that we can advantageously use.

The limiting factor, in practice, is the ability of materials to withstand, for long periods, sustained stresses at high temperatures without appreciable deformation, and so perhaps we might, with advantage at this stage, consider some of the more important factors relating to the composition and properties of metals which make them suited to high-temperature work.

Materials

Metals in gas turbines are not required to operate at higher temperatures than those at which metals have previously been used, nor are they expected to withstand higher stresses or resist more corrosive conditions than in other applications. They are, however, required to withstand different combinations of stress, temperature

and corrosion from those which prevail in other applications. In the gas turbines so far used in aircraft, the stress-temperature conditions have been very exacting in comparison with those to which metals are otherwise subjected, but long life has not been required, and owing to the fact that stress, temperature and time are all equally important under high/temperature conditions, it may be said that successful performance under exacting stress/temperature conditions has been achieved largely by reducing the time factor. Furthermore, hot-corrosion has been mitigated by careful selection of fuel. The development of the gas turbine for general use involves a very large increase in the required life. Consequently, the time factor becomes more exacting, and in addition hot-corrosion becomes much more important, since the components will be exposed for a longer time to more corrosive conditions resulting from the use of unselected fuel. It will be seen, therefore, that if general-purpose gas turbines are to succeed, the metals of which they are built must withstand exacting stress-temperature conditions if the machines are to be efficient, and they must withstand these and corrosive environments for a long time if the machines are to be reliable and commercially attractive. In other words, they will have to withstand combinations of stress, temperature, time and hot-corrosion which are different from, and generally more exacting than, any to which metals have hitherto been exposed.

We could not hope as part of a lecture such as this to survey the whole of the present position relating to the use of metals in the gas turbine, but we consider it is worth while to refer to some important features.

Creep

The use of metals under static stress at and near atmospheric temperature, centres to a large extent round the results obtained in tensile and notched-bar tests. It is known that if the stress to which the metal is subjected is less than its limit of proportionality, proof-stress or yield point, it will not change dimensions in use, since the deformation produced by a given stress does not increase appreciably with time. Furthermore, satisfactory values of ultimate tensile stress, elongation, reduction of area and notch toughness give an assurance that it will not fracture as a result of internal stress, local stress concentrations or sudden shocks. Tensile tests and notched-bar tests can be carried out in a matter of minutes, and they are the basic tests used by metallurgists in comparing different alloys and treatments, by designers in preparing designs, and by inspectors in accepting supplies.

When high-temperature applications of metals are involved, a much more elaborate procedure is required, in order to obtain information of equivalent value for use in design and inspection, and in comparing alloys and treatments. Under those conditions, time becomes of equal importance to stress, and as the effect of the combination of stress and time varies rapidly with changes in temperature, this also must be considered an equally important factor. Thus at high temperatures it is not just stress that has to be considered, but the stress/temperature/time combination, and this combination has to be taken into account in relation to both deformation and fracture.

When a metal is subjected to static stress at a high temperature, a certain amount of deformation is produced on the first application of the stress, and after that the

metal continues to deform with time. This is known as creep, and creep tests are carried out by measuring the extension at regular time intervals of specimens maintained under steady tensile stress at a constant temperature. A family of creep (or time-extension) curves for a particular metal, at a certain temperature, under various stresses, is shown in Fig. 25. Curve D in this figure may be said to be a typical creep curve. It shows that after the initial extension on the first application of the stress, the metal proceeds to extend at a diminishing rate until a minimum rate is attained at the point marked with a cross, after which it extends at an increasing rate which would eventually lead to fracture. Curves E, F and G indicate what occurs when higher stresses are applied, and curves A, B and C indicate what occurs when lower stresses are applied. On each curve the position of the minimum

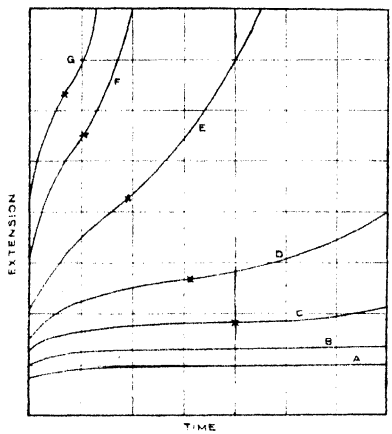


FIG. 25.—*Typical creep curves*

rate of creep is marked with a cross, except on curves A and B on which the minimum is not reached within the time covered by the figure.

Families of curves such as those shown in Fig. 25 are relevant to the behaviour of all metals at all temperatures, and all that happens in going from one metal to another, or one temperature to another, is that the time and extension scales and the values of the stresses represented by the different curves alter. Under the conditions which prevail in the use of metals for stressed parts at atmospheric temperature, no appreciable extension with time occurs, *i.e.*, the creep curve for the stresses employed is a horizontal line parallel to the time axis. As the temperature of operation is raised above atmospheric, the highest stress that may be applied without producing appreciable amounts of extension with time diminishes, and when a certain temperature, which depends on the metal or alloy concerned, is reached, the stresses that can be applied without producing appreciable amounts of creep, are so low that practical application is not worth while. It is under these conditions that creep must be taken into account in design and in comparing alloys and treatments.

From the practical point of view it is only metals which give curves like A and B

in Fig. 25, under the stress/temperature conditions involved, that are important, since, in general, amounts of deformation of the order indicated by the other curves could not be tolerated. Curves A and B relate to conditions under which creep is still proceeding at a diminishing rate at the end of the time period covered by the figure, but it must be borne in mind that after a sufficient time, a minimum rate will be reached, and after that creep at an increasing rate will begin.

Brittle Fracture

Unlike failure under normal temperature conditions, metals may, under certain conditions of stress, time and temperature, fracture without regard to the deformation which has previously taken place. Fractures of this type are known as premature or brittle.

The mechanism of failure by premature or brittle fracture is quite different from the normal mechanism of failure, but all that need be said about it here is that the brittle fracture occurs between the crystals while the normal fracture goes through them. The tendency for brittle fracture to occur increases with the temperature, the stress and with the length of time for which the metal is under stress. As it is a first essential in the use of metals at high temperature that they will not deform more than a certain amount under the stress/temperature/time conditions of service, alloys for the high-temperature applications are developed primarily with the object of getting them to withstand given combinations of stress and temperature for a longer time, of stress and time at a higher temperature, or of time and temperature under a greater stress. It is alloys which withstand exacting combinations of stress, time and temperature, without much deformation, that are used at high temperature, and the conditions of use are such as to favour brittle fracture, since the selection of composition and treatment in order to obtain improved creep performance does not necessarily improve resistance to brittle fracture, and may even have the opposite effect.

Thus, in the use of metals at high temperature it is not enough to know that they will not deform more than a permissible amount under the stress-temperature-time conditions involved. It is also necessary to know that they will not fracture under these conditions.

In so far as the relations between stress, temperature and time on the one hand, and deformation and fracture on the other, are concerned, it appears to us that the requirements of the designer are most suitably met in the following way: A series of specimens of an alloy are subjected to different constant stresses at a given temperature. The extension is measured at intervals and the tests are continued to fracture. From the information thus obtained, a diagram like Fig. 26 can be plotted. The horizontal lines, *a*, *b*, *c*, etc., represent the specimens subjected to different stresses and the points on these lines indicate the times at which 0·1, 0·2, 0·5, and 1·0 per cent. of extension and fracture occur. The sloping lines show how the time required to produce different amounts of creep or fracture varies with the stress.

From a diagram like Fig. 26 it is possible to read off the creep that will occur under a given stress, in a given time, or the stress that must not be exceeded if there is a limit to the amount of creep that can be tolerated, and for any stress and amount of creep selected, it is possible to see the margin between these conditions and those

which cause fracture. If the time range of the diagram covers the duration of the expected life of the alloy in use, the required answer can be obtained directly. If it does not, the sloping lines must be continued to lower stress and longer times, but such extrapolation is to be avoided whenever possible, because with lower stress and longer time the resistance of the material to deformation and fracture may fall substantially below that indicated by extrapolation.

For each alloy information like that indicated above is required for a series of temperatures, and it is preferable that the lowest and highest temperatures used should coincide approximately with the lowest and highest temperatures at which the alloy is likely to be used, so that it is not necessary to extrapolate in terms of stress and temperature. When information like this, covering four variables (*i.e.*, stress, temperature, time and deformation and fracture) has been accumulated, all kinds of cross plots are possible, and designers are in a position to judge which temperature/time conditions they may safely use in their designs. This information should be supplemented by details about the elongation and reduction in area at fracture, and where possible by any information that can be provided about changes going on in the metal and the maintenance or loss of ductility under creep conditions.

Metals Used at High Temperatures

If we neglect such special uses of metals as tungsten lamp filaments and molybdenum furnace windings, in which little stress or oxidation is involved, it may be said that the alloys which have been used at temperatures above 400°C. can be divided into six groups, as follows: low carbon steel, low alloy ferritic steels, high alloy ferritic steels, austenitic steels, nickel-chromium alloys, and special alloys. Before the advent of the aircraft gas turbine, alloys of all these types were available, and the development of the materials for the gas turbine has, until now, mainly involved the accumulation of information in the high-temperature mechanical properties of alloys previously used for resistance to oxidation, and the modification of the composition and treatment of those alloys in order to improve these properties.

During the last twenty-five years, substantial resources have been devoted to developing and determining the properties of low alloy steels suitable for use in steam, oil and chemical plant, under more exacting stress-temperature-time conditions than can be withstood by low carbon steel. A number of such steels, containing molybdenum, chromium, vanadium and sometimes silicon, in different amounts and combinations, have been introduced, and steels of this type have been used in Germany, and more recently in this country, for aircraft gas turbine discs. A characteristic of all these steels is that their resistance to oxidation is not very different from that of carbon steels, and it is unlikely that any steels in this series that can be produced will be suitable for long life under substantial stresses at temperatures above 540°C. (1,000°F.) or even as high as this.

The high alloy ferritic steels are essentially high-chromium steels and they can be divided into two classes, one of which includes the ordinary stainless irons and steels which contain varying amounts of carbon and from 12 to 18 per cent. of chromium, and which can be heat-treated, and a second group which includes the alloys containing 20–30 per cent. of chromium, which are brittle and cannot be heat-

treated. Stainless iron has been used extensively for steam turbine blades, but although these various high-chromium steels have many applications where their high resistance to oxidation is involved, they have not so far been used in gas turbines, because of their relatively low creep resistance as compared with austenitic steels and the brittleness of the higher chromium types. Important uses may, however, be found for them in long-life gas turbines, where resistance to gases containing sulphur compounds is important.

It was evident at the beginning that the low alloy ferritic steels, so widely used for stressed parts in steam plant, would be unsuitable for the hottest and most highly stressed parts of gas turbines, and attention was at once turned to the alloys that were known to have better creep and oxidation resistance, namely the austenitic heat-resisting steels and the nickel-chromium alloys. Before the advent of the gas turbine, a large number of heat-resisting austenitic steels were available, and the steps that have since been taken, have involved the study of the creep properties and investigation of the effects of variations in treatment and composition. All these steels contain iron as the basic metal, chromium to give resistance to oxidation, and nickel to retain the iron in the austenitic condition. Different individual steels differ in the relative amounts of iron, nickel and chromium they contain, the amounts and combinations in which cobalt, molybdenum, titanium, columbium, and tungsten are added and in the heat treatment they are given. Many different nickel-chromium alloys containing varying amounts of chromium and nickel were available before the gas turbine became a practical proposition. Of these the alloy containing 80 per cent. of nickel and 20 per cent. of chromium was the best known and the most widely used, and alloys suitable for the hottest and/or most highly stressed parts of the gas turbine have been developed from this. In Britain, alloys derived from the 80/20 nickel-chromium alloy have been the most widely used for blades, but in America alloys based on chromium-cobalt, nickel-molybdenum, and chromium-nickel-cobalt have been most popular.

At the present time a wide range of alloys is available from which to select those suitable for operating under different stress/temperature/time conditions in different parts of the gas turbine and its accessories, and there are infinite possibilities for the development of new alloys and for variations in their treatment. The types of alloys that are particularly associated with the gas turbine are the austenitic steels and the nickel-chromium, nickel-molybdenum, and cobalt-chromium alloys mentioned above. Many more austenitic steels are certain to be developed and there is no end to the number of different alloys that may be produced by combining nickel, chromium, cobalt, molybdenum, titanium, columbium, and tungsten in different ways. It is, however, easier to devise new alloys than to obtain the information about their properties that is required before they can be put into service; and it is this that will control the rate of progress.

The Design of the Turbine

Evaluation of the properties of the materials available brings us to the important question of their most profitable use—that is, the design of the turbine.

In the first place, following the step-by-step examination of the cycle, we may

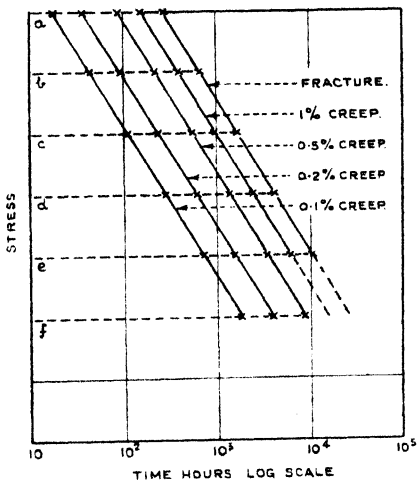
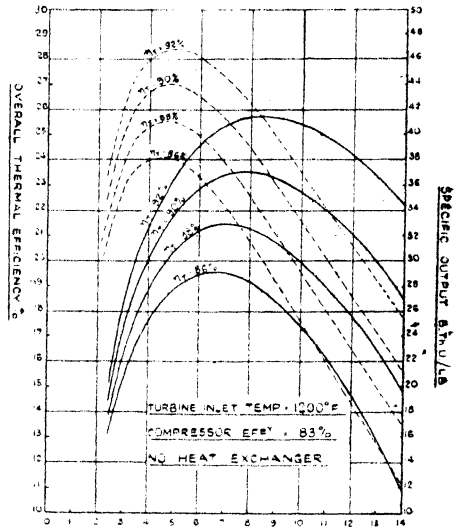


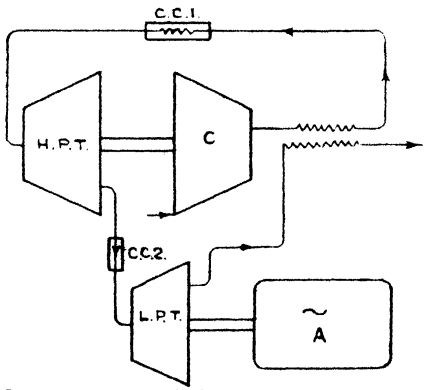
DIAGRAM ILLUSTRATING PLOT OF STRESS AGAINST LOG OF TIME FOR FRACTURE AND DIFFERENT AMOUNTS OF CREEP AT A GIVEN TEMPERATURE.

FIG. 26



VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPN RATIO FOR DIFFERENT TURBINE EFFYS (NO HEAT EXCHANGER)

FIG. 27



C.C.1. COMBUSTION CHAMBER.

H.P.T. HIGH PRESSURE COMPRESSOR TURBINE.

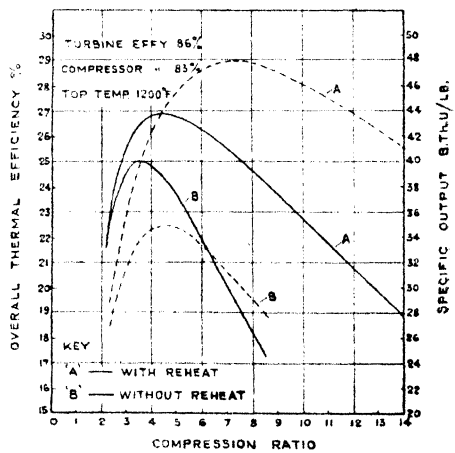
C COMPRESSOR.

L.P.T. LOW PRESSURE WORK TURBINE.

A ALTERNATOR.

C.C.2. REHEAT COMBUSTION CHAMBER.

FIG. 28.—*Gas turbine with single stage of reheat*



EFFECT OF REHEAT ON THE OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) OF A SIMPLE CYCLE EMPLOYING A 75% EFFECTIVE HEAT EXCHANGER.

FIG. 29

briefly, by reference to the T.Ø. diagram, consider some of the thermodynamic questions involved.

Referring to Fig. 7, polytropic expansion takes place along CD, the work done being given by $(H_c - H_d)$. Had the expansion been truly adiabatic, expansion would have occurred along CT resulting in increased work done by the amount $(H_d - H_t)$. An increase in turbine efficiency has, in general, a greater effect on the overall efficiency and specific output than a corresponding increase in the compressor efficiency, and in this regard the curves in Fig. 27, showing the variation in efficiency and specific output, with varying turbine efficiency on a base of compression ratio, make an interesting comparison with the corresponding curves in Fig. 16. As before the gas temperature is taken at 1,200°F.

It will be noted that in general the configuration is similar, but a high turbine efficiency is seen to be more important than a high compressor efficiency in that the contribution to the overall efficiency of an increase of the former is roughly 1·7 times that of the latter. The addition of a heat exchanger, as will be noted from the corresponding curves in Figs. 19 (*b*) and 20 (*b*), reduces this figure to the order of 1·3. In the area of optimum compression ratio, 1 per cent. increase in turbine efficiency increases the specific output by approximately 4 per cent.

In seeking to increase the work factor, we may obtain a very considerable gain by reheating the working medium and carrying out the total expansion between the upper and lower pressure limits in two or more stages. While this is costly in so far as the turbine is concerned, it does, for a given nett output, decrease the size of the compressor and the heat exchanger, and permits of extending the work capacity of the open cycle. The process is shown in the T.Ø. diagram Fig. 7, and the line diagram, Fig. 28, for a single stage of reheating. After expanding in one turbine unit to the point O, the working medium is exhausted to a second combustion chamber where additional fuel is burned at approximately constant pressure along OX, to return the medium to approximately its original temperature T_c at point X. Thereafter, it is led to a second turbine where the expansion to the final pressure takes place along XR.

The efficiency of the non-regenerative cycle given by the relationship

$$\frac{(H_c - H_o) + (H_x - H_r) - (H_b - H_a)}{(H_c - H_b) + (H_x - H_o)}$$

shows but a slight improvement over that given by a single expansion, but obviously the work done, as represented by $(H_c - H_o) + (H_c - H_r)$ is greater, and so the specific output and work factor are increased.

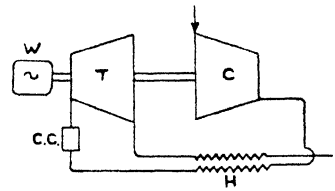
In a unit incorporating a heat exchanger, reheating results in a considerable improvement in efficiency, as may be observed from a study of Fig. 29, which also shows very clearly the substantial increase in specific output.

Apart from the advantages indicated above, the reheating principle gives greater flexibility of control, in that it provides a measure of independence to a separate work turbine, entirely divorced or only part coupled to the compression load. This will be clearly seen by reference to Fig. 30, which shows (*a*) a single-line unit with work turbine direct coupled to output and compressor, (*b*) a two-line unit with work and compressor turbines in series, and (*c*) a similar arrangement to (*b*), but with reheating interposed between the high and low-pressure turbines. By means of the

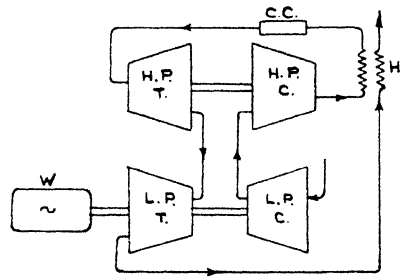
reheating combustion chamber in (*c*), the load division as required by useful output and compression work, is under relatively independent control.

Provided materials have been selected with care and conservatively stressed at the prevailing temperatures, gas turbine design problems are not much different from those experienced in the design of steam plant. Generally speaking, conditions are

T. TURBINE.
C. COMPRESSOR.
C.C. COMBUSTION CHAMBER.
H. HEAT EXCHANGER.
W. WORK.



H.P.T. HIGH PRESSURE TURBINE.
L.P.T. LOW PRESSURE TURBINE.
L.P.C. LOW PRESSURE COMPRESSOR.
H.P.C. HIGH PRESSURE COMPRESSOR.
W. WORK
H. HEAT EXCHANGER.



H.P.T. HIGH PRESSURE TURBINE.
L.P.T. LOW PRESSURE TURBINE.
L.P.C. LOW PRESSURE COMPRESSOR.
H.P.C. HIGH PRESSURE COMPRESSOR.
W. WORK.
H. HEAT EXCHANGER.
R.H. REHEAT COMBUSTION CHAMBER.

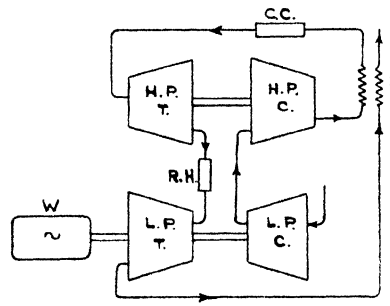


FIG. 30.—(*a*) *Single line unit with work turbine direct coupled to output and compressor.* (*b*) *Two line unit with work and compressor turbines in series.* (*c*) *Two line unit with one stage of reheat*)

favourable for a high-efficiency turbine—large mass flow and good-sized blade heights.

HOLLOW BLADES

The use of hollow air-cooled blades as a means of using higher gas temperatures is tempting. There are, however, a number of factors which must be carefully considered in any given design before resorting to their use.

They were used in Germany to a very considerable extent in war-time gas turbine construction for jet engines, but as Reeman* has pointed out, the efficiencies of such units, obtained on test, would not have been tolerated in this country. This is largely due in the first place to the initially bad blade shape which must be adopted

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where air cooling is resorted to, and in the second, to the thickness of the trailing edge. Tests on steam turbine blading carried out at Parsons' Heaton Works, showed that on standard 640B type blading, an increase in tail thickness (expressed as $\left(\frac{2 \times \text{Radius}}{\text{Chord}}\right)$ of from 2 per cent. to 4 per cent., increased the loss (expressed as $\left(\frac{\text{Loss}}{\text{Adiabatic Heat Drop}}\right)$ by as much as 3 per cent. Again, to obtain adequate cooling (according to the actual working temperature selected), some 2 to 4 per cent. of the total quantity of air compressed must be used, and while a small proportion of the loss involved is regained in subsequent expansion, the loss in efficiency is still very considerable.

Lastly, with a high thermal ratio heat exchanger, the dilution effect of the cooling air on the exhaust temperature has a serious effect on the efficiency of heat transfer and may in fact, if excessive, offset the thermodynamic gain by the use of the higher gas temperature.

Other factors which militate against the use of hollow blades are the difficulties of manufacture in heat-resisting materials to the fine tolerances demanded. Such materials are notoriously difficult to draw or forge, and obviously, since to pay their way hollow blades must be thin walled, small variations in their cross-sectional area will have a considerable, and possibly dangerous effect on the stress induced by centrifugal and gas bending forces. It must be emphasised however, that these remarks are not made with a view to condemning the use of hollow blades, but to emphasise the caution with which they must be introduced.

The Heat Exchanger

A short study of the heat cycle up to this stage has brought us to what is always the most important point in any heat cycle—"The waste heat and what to do with it". If we were obliged to reject the heat at the relatively high temperature obtaining in the gas turbine exhaust, there would be small hope of economical competition with established steam and internal combustion prime movers, but here, as in the steam turbine, we are dealing with purely rotating units which can readily accommodate large volumes, and whereas in the reciprocating internal combustion engine we could not afford, from volume considerations alone, to make use of the exhaust heat in preheating the combustion air supply, conditions are ideal for such an exchange iu the gas turbine.

Accordingly, the heat exchanger which allows of an interchange of the heat between the exhaust products and the ingoing air to the combustion chamber, is one of the most important considerations in gas turbine design and one that calls for the most careful analysis. Its use results in a reduction of the maximum optimum compression ratio. This has a dual effect: it reduces the work of compression and increases the compressor efficiency. The lower working pressure also results in lower parasitic losses in the turbine. On all counts therefore, *provided*, as we shall see later, the pressure loss is kept to a minimum, the heat exchanger pays the most handsome dividends.

Theoretically, we may obtain 100 per cent. efficiency of heat transfer between outlet gas and inlet air, but in practice, owing to the space factors involved in

normal types of installations, we must be content with efficiencies (expressed generally as Thermal Ratio, given by $\left(\frac{\text{Heat actually transferred to air}}{\text{Maximum possible transfer}}\right)$ of the order of 75 to 85 per cent.

If we may again refer to our T.Ø. diagram (reproduced in Fig. 22) we should theoretically be able to heat the air to a temperature T_d (point M), leaving only an amount of heat ($H_c - H_d$) to be supplied by the fuel. Similarly we should, theoretically, be able to reject at the lowered temperature T_b (point J). In practice, as mentioned previously, owing to dimensional limitations, we must have a considerable temperature difference between inlet exhaust and leaving air, and inlet air and leaving exhaust temperatures, and so our exhaust temperature might (according to the thermal ratio adopted) correspond to the point K and our outlet air temperature to point L.

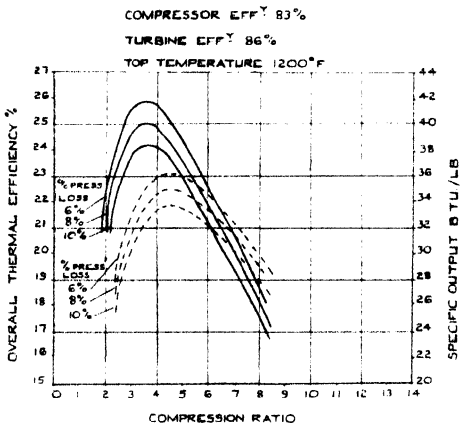
In addition to these losses dictated by considerations of size, and therefore of cost, the heat interchange involves a pressure loss which may, unless carefully designed against, have the most serious repercussions on the work ratio and specific output. In passing through the heat exchanger, the drop in pressure on the air side due to frictional effects, is represented on our T.Ø. diagram (Fig. 22) by the shifting of point W to a point of lower pressure at the same temperature C_1, and this is now the state point before expansion. The back pressure on the turbine, having been increased by the head necessary to overcome friction on the hot side of the heat exchanger, expansion will now take place along $C_1 - D_1$ (the point D_1 now being above atmospheric pressure), instead of as formerly (with no pressure losses) along C—D, and with combustion chamber losses only considered, W—Y. Accordingly, against the heat gain obtained by the introduction of the heat exchanger represented by ($H_L - H_b$) must be offset the loss in output $H_{d1} - H_y$).

In view of the importance of the heat exchanger in the gas turbine cycle, we have thought it worth while to attempt to elaborate on the effects of this component on cycle efficiency and specific output. To this end, Figs. 19 (A, B and C) and 20 (A, B and E), relating to a 75 per cent. and 85 per cent. thermal-ratio heat exchanger respectively, allow of a fairly searching analysis being made, particularly if they are compared with Figs. 16, 18 and 27 relating to a simple unit without heat exchanger. We need not do more than mention some of the more outstanding features.

Firstly, in regard to efficiency, to take but one example, after making a normal allowance for pressure losses involved, it is seen that, for a working gas temperature of 1,200°F., the maximum overall efficiency is raised progressively from the order of 20 per cent. to some 25 per cent. with the addition of a 75 per cent. effective heat exchanger and to approximately 28 per cent. when an 85 per cent. effective exchanger is fitted. At the same time the optimum compression ratio has been reduced from 6 to 3·5 and 3 respectively. Secondly, owing to the increased pressure loss, it will be noted that the maximum specific output for the regenerative cycles has been reduced by some 8 per cent. in comparison with that of the non-regenerative, but in large plants this loss will be more than made good by the employment of intercooling and reheating, which, in addition to improving specific output, will both add to the effectiveness of the heat exchanger and hence, for a given bulk, increase the efficiency of the cycle for a given cost. It is most important therefore that the heat

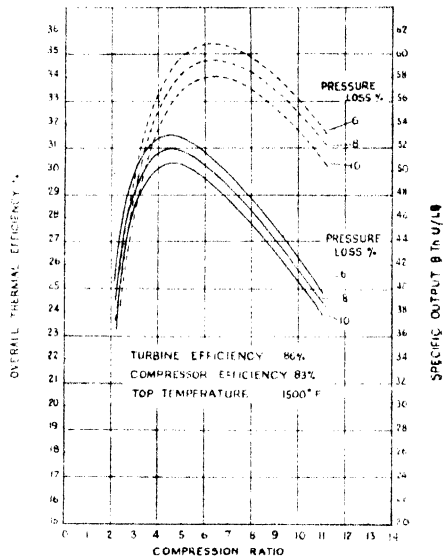
exchanger be dimensioned in such a way as to keep the pressure drop—particularly on the hot side—to a minimum.

A series of curves showing variations in efficiency and specific output for varying degrees of pressure loss in a 75 per cent. effective heat exchanger at 1,200°F. and 1,500°F. are shown in Figs. 31 and 32 respectively. In plotting these curves, the turbine and compressor efficiencies have been kept constant and the pressure loss in the pipes and combustion chambers has been maintained at a constant figure of 3 per cent. It will be seen that in general a small variation in pressure losses results in a greater variation in performance at low compression ratios and low maximum



VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) FOR DIFFERENT VALUES OF % AGE PRESSURE LOSS (WITH 75% EFFECTIVE HEAT EXCHANGER)

FIG. 31



VARIATION OF OVERALL THERMAL EFFICIENCY (FULL LINES) AND SPECIFIC OUTPUT (BROKEN LINES) WITH COMPRESSION RATIO FOR DIFFERENT PRESSURE LOSSES AND A 75% EFFECTIVE EXCHANGER

FIG. 32

temperatures, and that the effect decreases with increasing compression ratios and increasing maximum temperatures.

To evaluate the effect of the losses in a simple manner, we may consider that a pressure loss corresponds to a reduced expansion ratio, and at low pressures and low maximum temperatures a 1 per cent. change in the expansion ratio is very roughly equivalent to a 1 per cent. change in turbine efficiency. The turbine efficiency is thus equal in importance to the pressure losses.

At higher compression ratios and higher maximum temperatures, the effect of turbine efficiency is still very great and exceeds the effect of the pressure losses, a 1 per cent. change in the expansion ratio being roughly equivalent to 0·5 per cent. change in the turbine efficiency.

Generalising we may say that at low compression ratios the turbine efficiency and pressure losses are equally important: at high compression ratios the turbine efficiency assumes the greater importance.

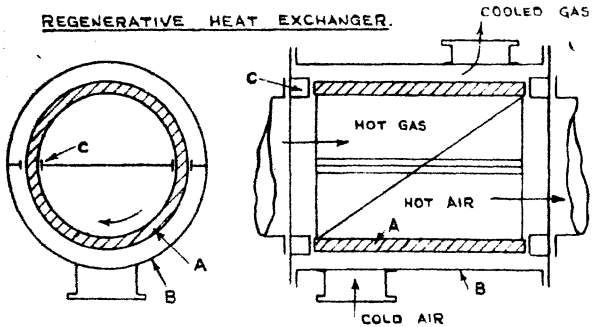


FIG. 33.—*A regenerative type heat exchanger*

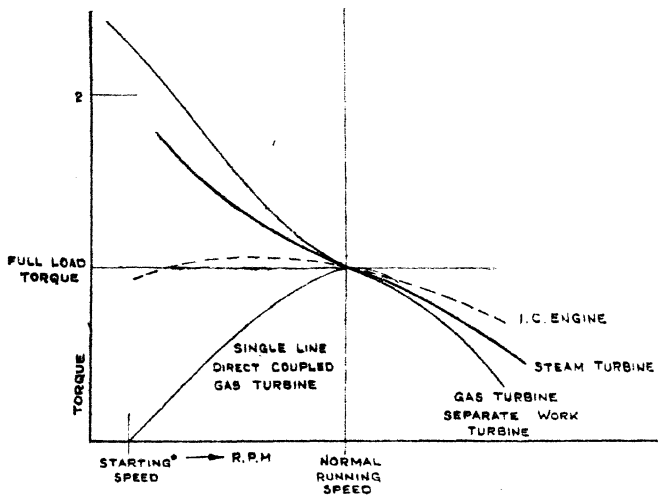


FIG. 35.—*Torque-speed relationships*

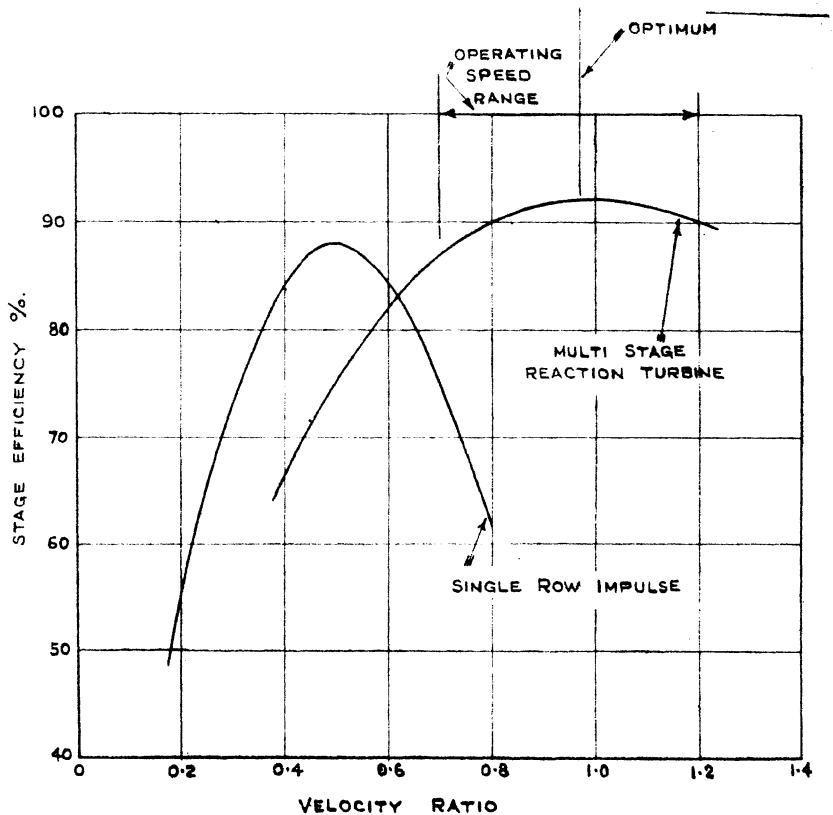


FIG. 34.—*Relationship between efficiency and blade speed ratio*

At part loads, provided the flow remains turbulent, the thermal ratio of the heat exchanger increases, due to the smaller gas and air flow for a constant heat exchanger surface. It is for this reason that a heat exchanger is so important at part loads when normally the efficiency of the turbine and compressor group falls.

Heat exchangers built on the well-established shell and tube principle become very bulky for thermal ratios of 70 per cent. and over, and considerable thought has therefore been given to small tube and secondary surface types in an effort to reduce the heat exchanger to dimensions more in keeping with the other plant components.

Minimum dimensions for a given mass flow and thermal ratio are obtained by the use of heat exchangers built on the regenerative principle. The Ljungström type of air preheater, well known in steam boiler practice, is illustrative of the principle. Owing however, to the large pressure differences between the hot and cold sides in a gas turbine plant, sealing becomes a major problem. This, together with the distortion which inevitably results from uneven heating, makes successful design a matter of extreme difficulty. Nevertheless, the prize is so great that some of the most agile engineering minds in the world are concentrating on the solution.

A rough outline of the principle of a regenerative type heat exchanger for a gas turbine unit is shown in Fig. 33. Here A is a cylindrical matrix of metal or ceramic, rotating within the casing B and through which pass both hot gas and cold air. Their paths are separated by sealings C running along the length and round the ends of the cylinder. The gas and air flow in counter directions through the matrix and there is thus a tendency to self-cleaning. Flow is laminar and friction losses therefore small. The matrix provides a means of obtaining a minute hydraulic tube diameter (of the order of 2 mm., if necessary) and so the length of the gas path, through the matrix need only be of the order of a few inches. There can be little doubt but that, if the sealing difficulty can be overcome, the regenerative principle of heat exchange will, as much as any other single factor, serve to establish the gas turbine in industry.

Operating Characteristics

Having now briefly considered some of the more important factors which govern the efficiency of the gas turbine, we may, before going on to discuss specific applications, look at some of its operating characteristics.

In common with steam turbines, the gas turbine has an optimum efficiency at a certain blade/gas speed ratio, the exact value of which depends mainly on the type of blading selected. As the speed ratio varies from this optimum so does the efficiency. A typical efficiency/blade speed ratio relationship for a multi-stage reaction turbine is shown in Fig. 34. For comparison, the corresponding curve for a single-stage impulse wheel is shown. The principal difference between the two types is the relatively flat efficiency curve for the reaction type blading over a fairly wide range of velocity ratios.

The torque-speed characteristics obtainable from a gas turbine are determined by the disposition of the compressor and turbine units. For a simple gas turbine unit with the turbine direct coupled to the compressor, the corresponding torque/speed curve is shown in Fig. 35. As will be noted, the torque decreases with decrease in speed, due to the fact that the mass flow delivered by the compressor decreases as

the speed is reduced and, in fact, below a certain speed depending on compressor and turbine characteristics, the nett torque is zero. In comparison, the torque obtainable with a steam turbine (also shown in Fig. 35) increases as the speed decreases, owing to the fact that the full flow of steam is provided throughout the speed range. These characteristics of the simple coupled gas turbine are acceptable from a purely mechanical point of view, in certain power requirements, as for instance, in constant speed electrical power generation. Even so, the efficiency under part load conditions in the latter application are poor, since load variation can only be effected by reducing the inlet temperature, which in turn reduces the compressor delivery pressure and slightly increases the mass flow. Under these conditions the compressor efficiency is reduced below the design point for full load conditions.

However, these torque and part load efficiency limitations may be overcome by the adoption of a two-line arrangement, where the work turbine is separated from the compressor, the latter being driven by a separate turbine running in series or in parallel with the work turbine. Such a system is outlined diagrammatically in Fig. 28, which shows the low-pressure turbine direct coupled to the alternator working in series with the separated high-pressure turbine which drives the compressor. In this way the compressor may be driven independently of the work turbine and therefore under more or less constant efficiency conditions.

For still greater independence of control (and efficiency with a high thermal ratio heat exchanger) a second or reheat combustion chamber may be interposed, as indicated, between the high-pressure and low-pressure turbines. With a separate work turbine, the torque-speed relationship is as shown in Fig. 35 and is now, it will be observed, of a form comparable with that obtainable from a steam turbine. The stall torque may, in practice, be more than twice the normal speed torque. For traction purposes this is a most desirable feature. Where simplicity and first cost are more important than efficiency, it may be used advantageously to the exclusion of a gear box or other form of torque converter necessary, for example, in a motor-car or locomotive driven by an internal combustion engine, on account of the torque characteristics of the latter as indicated in Fig. 35. This reasoning applies where the traction unit is working under high-torque low-speed conditions for relatively short periods.

Normally, however, these excellent torque characteristics of the two-line gas turbine unit cannot be fully realised, since at velocity ratios greater or less than the optimum, the efficiency drops, as indicated in Fig. 34, and so fuel costs increase. In practice therefore, for most traction purposes we may only work efficiently over a limited velocity ratio range (dictated by the exact form of the efficiency/speed ratio curve) and interpose a relatively simple mechanical or hydraulic transmission or alternatively, electrical transmission between the work turbine and the driven member.

Some of the more important operating characteristics of a separated work turbine combination are shown in Figs. 36–38. Fig. 36 shows the power-speed relationships for synchronous working and for speed ratios of the working turbine in relation to the compressor turbine between 0·7 and 1·3. The corresponding torque-speed curves between the same speed limits are shown in Fig. 37.

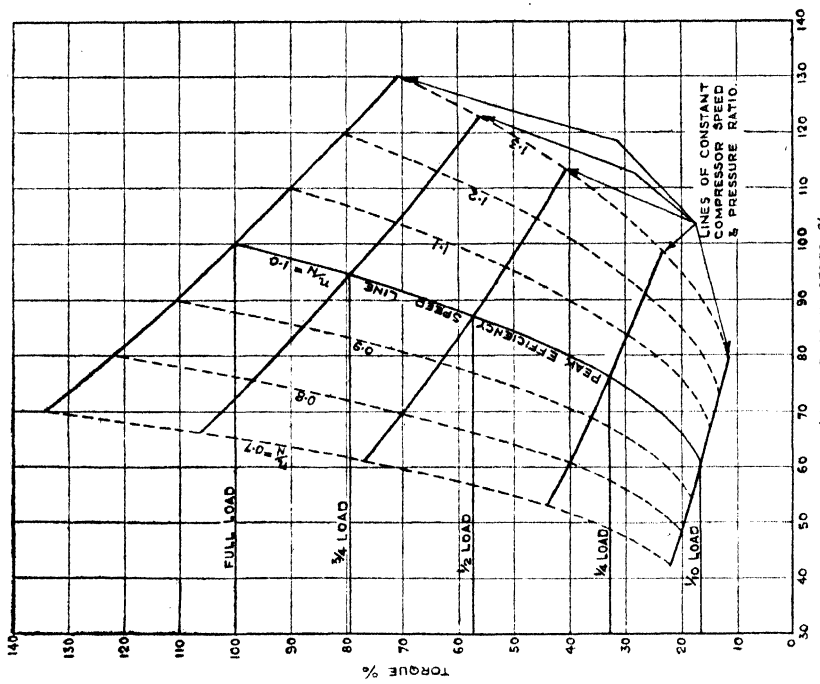

TORQUE V SPEED CHARACTERISTICS FOR GAS TURBINE WITH SERIES WORK TURBINE.
TORQUE %
WORK TURBINE SPEED %.
FULL LOAD
¾ LOAD
½ LOAD
¼ LOAD
1/10 LOAD
PEAK EFFICIENCY SPEED LINE
LINES OF CONSTANT COMPRESSOR SPEED & PRESSURE RATIO.
1·3
1·2
1·1
1·0
0·9
0·8
0·7

FIG. 37

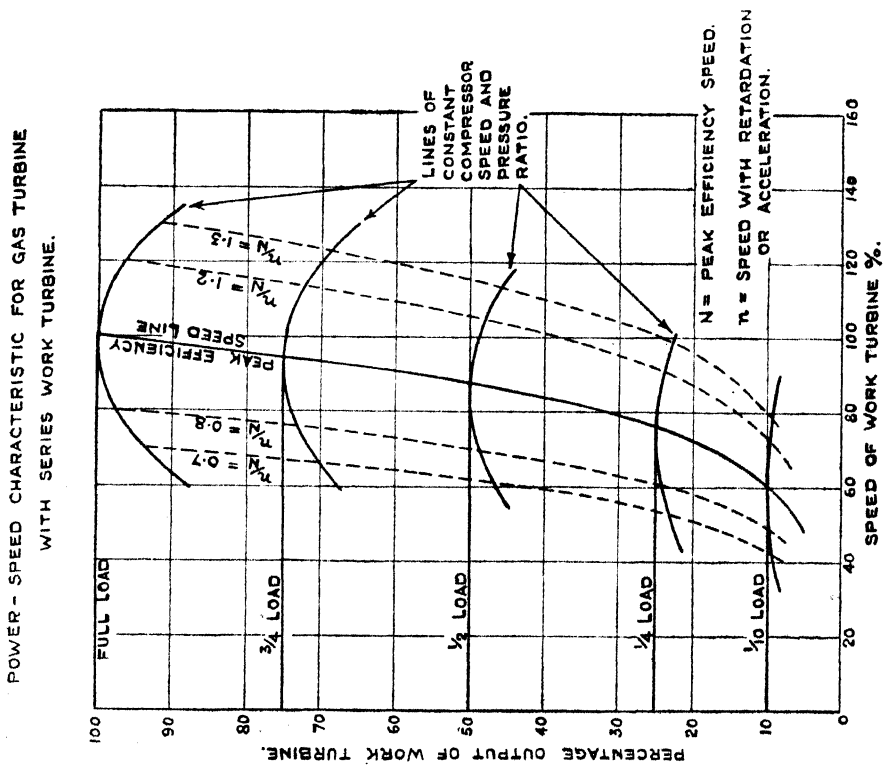

POWER - SPEED CHARACTERISTIC FOR GAS TURBINE WITH SERIES WORK TURBINE.
PERCENTAGE OUTPUT OF WORK TURBINE.
SPEED OF WORK TURBINE %.
FULL LOAD
¾ LOAD
½ LOAD
¼ LOAD
1/10 LOAD
PEAK EFFICIENCY SPEED LINE
LINES OF CONSTANT COMPRESSOR SPEED AND PRESSURE RATIO.
N = PEAK EFFICIENCY SPEED.
n = SPEED WITH RETARDATION OR ACCELERATION.

FIG. 36

Taking as an example the torque variations at full load conditions, it is seen that, compressor speed remaining constant, a decrease in the speed of the work turbine to 0·7 of its synchronous value results in a torque increase of 30 per cent. The penalty paid in increased specific fuel consumption for this privilege is shown in Fig. 38, where, for example, between the point "A" representing optimum full load conditions, and point "B" representing a torque increase of 30 per cent. over

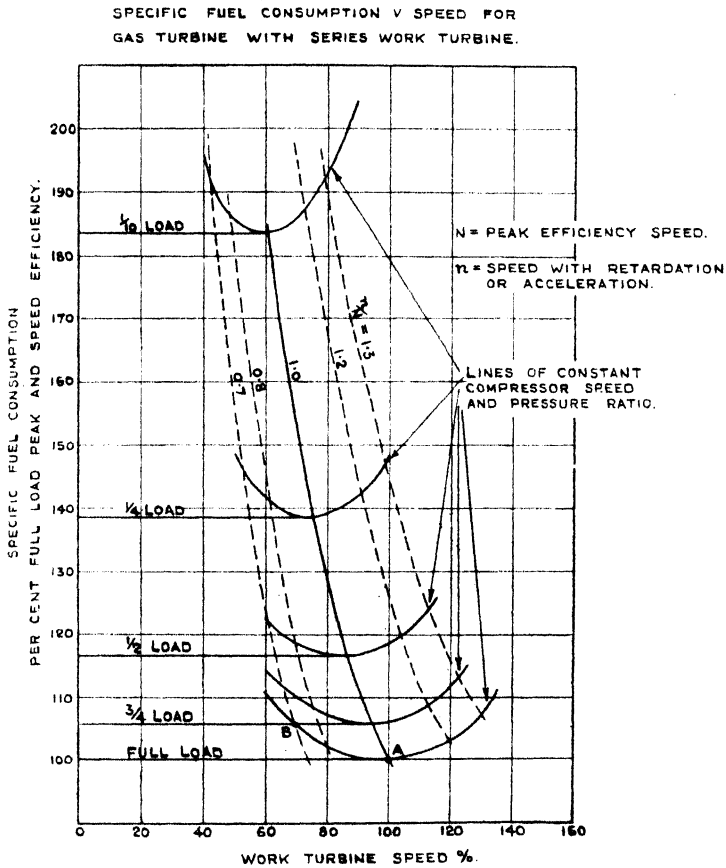
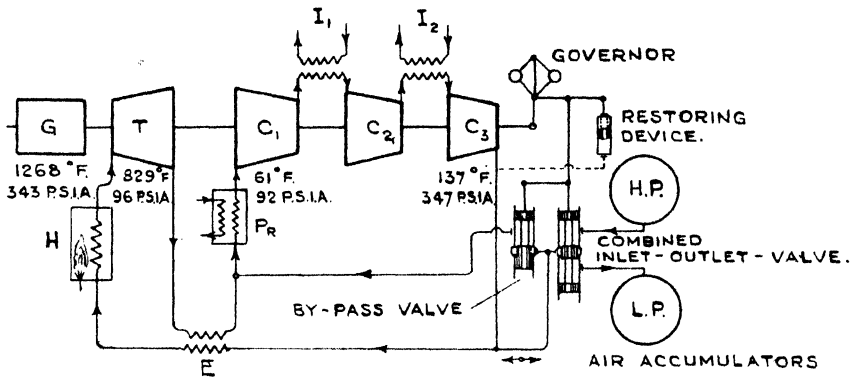


FIG. 38

that obtainable under such conditions, the increase in specific consumption is of the order of 6 per cent.

CONSIDERATIONS AFFECTING INDUSTRIAL APPLICATIONS

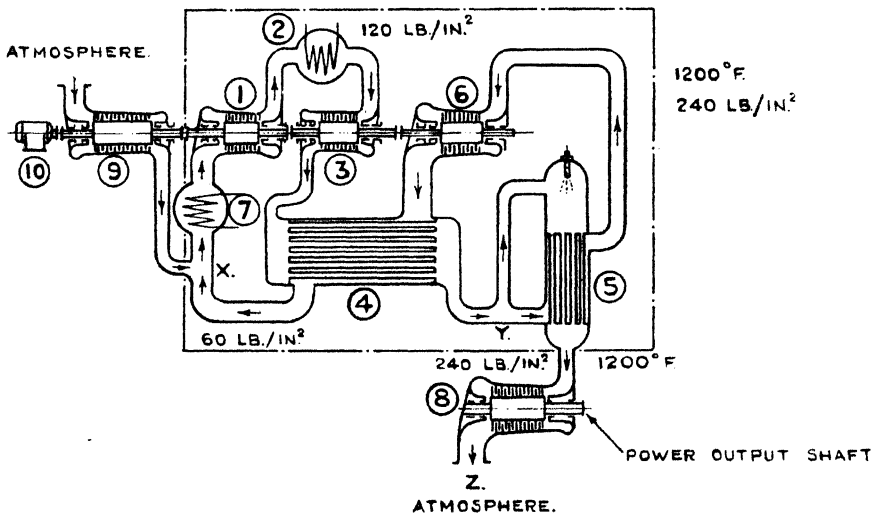
The survey which has been made of some of the more important technical considerations governing gas turbine design and operation will, it is hoped, suffice to allow of an appreciation being formed of the possibilities and limitations of industrial applications of this new prime mover. It is now proposed to consider briefly some of the more important fields which, in the light of present and probable developments, it may be expected to cover.



G.	GENERATOR.	I_1, I_2.	INTERCOOLERS.
T.	TURBINE.	H.	AIR HEATER.
C_1.	L.P. COMPRESSOR.	P_R.	PRECOOLER
C_2.	I.P. COMPRESSOR.	H.P.	HIGH PRESSURE RECEIVER.
C_3	H.P. COMPRESSOR.	L.P.	LOW PRESSURE RECEIVER.
		E.	HEAT EXCHANGER.

(Reproduced by courtesy of "Transactions of the A.S.M.E.")

FIG. 39.—*Closed cycle turbine (Escher Wyss)*



(1)	L.P. COMPRESSOR.	(6)	COMPRESSOR TURBINE.
(2)	INTERCOOLER.	(7)	PRE COOLER.
(3)	H.P COMPRESSOR.	(8)	WORK TURBINE.
(4)	HEAT EXCHANGER.	(9)	COMPRESSOR SUPPLYING COMBUSTION AIR.
(5)	COMBUSTION CHAMBER	(10)	STARTING MOTOR.

(Reproduced by courtesy of the North East Coast Institution of Engineers and Shipbuilders)

FIG. 40.—*Semi-closed cycle turbine (Sulzer Bros.)*

In the first place, on account of the enormous volumes involved, the space occupied, and the capacity limitations of the low pressure turbine blading, it is doubtful if the simple and attractive open cycle can economically deal with the large power outputs demanded of central power station units. This serves to focus attention on the closed or semi-closed cycle of operations, which allow of the mean pressure in the system being raised to such levels as limit the volume to manageable proportions.

The closed cycle has been briefly described, but in order that its implications may be more fully appreciated, a diagram, Fig. 39, shows it in a form developed by its chief proponents, Messrs. Escher Wyss.* Referring to Fig. 39, which relates to a single shaft unit, the closed cycle is substantially that described previously. Air circulates at pressures and temperatures determined by specific requirements, but for the simple plant shown the compression ratio is of the order of 3 to 4 and the pressure and temperature figures may be of the order shown, the absolute pressure being varied to suit load requirements.

Minor or short-term fluctuations are controlled by adding or withdrawing air to or from the circuit. Adjustments to the externally fired air heater are rather in the nature of long term changes since, obviously, owing to the large heat capacity involved, rapid power fluctuations could not be dealt with solely by change of rate of fuel injection.

The system of governing by variation of the quantity of air in circulation is shown to the right of the closed cycle diagram proper. When the load is thrown off with consequent rise in speed, the combined inlet-outlet valve is acted upon by the centrifugal governor allowing air from the high-pressure side of the circuit to be discharged into the low-pressure receiver. Conversely, with increasing load and consequent speed reduction, air flows from the high-pressure receiver into the circuit at the same point as that from which it was removed to accommodate a load decrease. Small reductions in load are met by by-passing air from the high-pressure to the low-pressure circuits by means of the by-pass valve shown. As will be clear from this short description, a plant of this type has the advantage of a high mean pressure throughout the system, and accordingly relatively small compressor, turbine, and heat exchanger units may be used. Only air or other working medium free from contamination with combustion products is in circulation, and the externally fired boiler offers at least the possibility of burning fuels unsuited to the open cycle.

Its chief disadvantages lie in the bulk, inefficiency, cost, complication and design difficulties of the air boiler compared with the direct combustion chamber of the open cycle, the relatively large amount of cooling water required, and the relatively costly and complicated load control gear.

A number of semi-closed cycles have been proposed and that now being developed by Messrs. Sulzer Bros., in Switzerland, is chosen as an example of this type. Referring to Fig. 40†, the closed cycle proper is substantially contained within the

*Reproduced from *Transactions of the A.S.M.E.* Vol. 68, No. 8, November, 1946, p. 793. "The Escher Wyss A.K. Closed Cycle," C. Kellar.

†Reproduced by kind permission of the North East Coast Institution of Engineers and Shipbuilders. *Transactions*, Vol. 62, Part 7. "Some Researches in Internal Combustion Turbines," by J. Calderwood, M.SC.

rectangle shown on the diagram and is seen to consist essentially of the two-stage compressors (1) and (3) with precooler (7) and intercooler (2), supplying air *via* the heat exchanger (4) to the combustion chamber (5) where it receives heat indirectly. After expanding in the turbine (6) coupled to the compressors, the air returns by way of the heat exchanger and is again returned to the compressor circuit.

The air for combustion is drawn from the atmosphere by the compressor (9). After mixing with the closed circuit air at point X and after following the same circuit to the point Y, it is divorced from the latter as shown and burned in the combustion chamber providing at one and the same time a source of heat for the

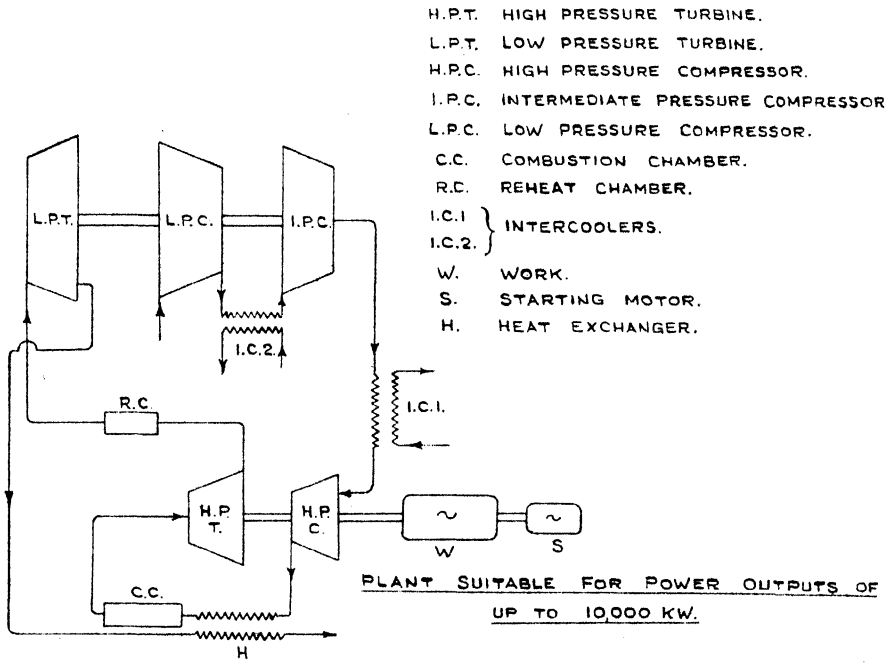


FIG. 41.—*Diagram of layout for large power generating unit*

externally-heated closed circuit air and the working medium for the work turbine (8). It is finally exhausted to atmosphere at point Z.

It will be observed from the above description, that the principal difference between this and the fully closed cycle, lies chiefly in the reduction in size of the air boiler due to the fact that the working medium for the work turbine is obtained through direct combustion.

Control is complicated, and unlike the closed cycle, the fuel used must be acceptable to the turbine. In this regard, therefore, it holds no advantage over the open cycle.

INDUSTRIAL APPLICATIONS

In the following considerations relating to industrial applications of the gas turbine,

the authors propose to confine their remarks to units operating on the open cycle, since their direct experience has so far been confined to such.

In comparison with the open cycle, experience on closed cycle units has been very limited, and only long time operating results will overcome the prejudice of most engineers to the "air boiler" which forms the basis of the closed cycle design. The Swiss engineers, who are concentrating on the problems associated with externally fired air heaters, are however to be congratulated on their work to date, and it may be that if the gas turbine is to compete with, or replace, large central power station steam units, it will be by way of the closed or semi-closed cycle. Meantime, with open cycle units of medium output available, central power station interests are likely to be centred in machines for standby or peak-load requirements. With conservative stressing for long life, the known properties of heat-resisting materials now available for commercial designs will allow of a working gas temperature of some 650°C., which should permit of a full-load efficiency of some 26 to 29 per cent. This compares reasonably well with modern steam units of similar capacity.

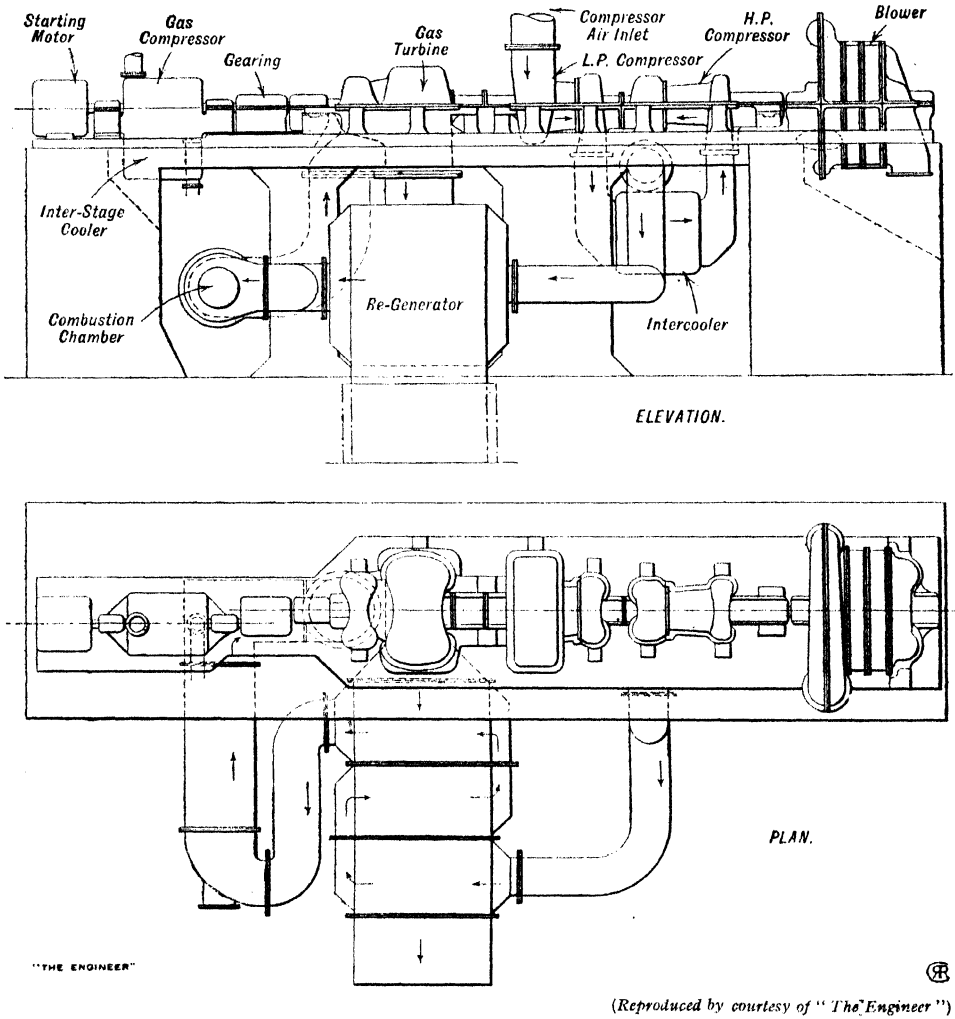
The installed cost of a gas turbine unit will, in general, be less than that of a corresponding steam plant; but the actual differences will, of course, depend very largely on local conditions, availability of cooling water, and so on. In this connection it must be borne in mind that whether it works on the closed or open cycle, the cooling water requirements of a large gas turbine unit are not negligible and may well be 50 per cent. of the requirements for a high-efficiency steam turbine plant of comparable size. A cycle diagram of the type of layout suitable for a large power generating unit is indicated in Fig. 41.

What then of the economics of the gas turbine for power generation ? They are, we think, reasonably well definable. There is no reason to believe that with conservative stressing it will not have a useful life, reliability and efficiency comparable with a steam plant. Its first cost will, in general, be less than that of a combined steam turbine and boiler plant. Maintenance costs should compare favourably with those of a steam plant. But—and this is the most important criterion—unless it can burn coal, or unless the relative cost of oil and coal become less than 2 : 1, the gas turbine is not likely to prove an economical proposition. Nor would it be strategically desirable for large-scale power generation in a country like England, rich in coal and poor in home-produced oil, to be largely dependent on the former fuel. There are, of course, exceptions to this broad statement, but these are readily determined by the particular circumstances obtaining in any specific instance. As previously indicated, for standby or peak-load requirements the gas turbine is eminently suitable. Where water is scarce or supply expensive, it demands consideration. Under certain combinations of heating and power requirements it may prove economical. The use of oil, for these and other outlets, in the quantities required to meet them would not be an embarrassment to our national economy or defence and does not invalidate our general contention.

Can coal be burned in the gas turbine? Not yet. Slagging in the closed cycle, fouling of the turbine in the open cycle, are the deterrents, but a great deal of research is being made into this question in England, Switzerland and America, with promising results.

Where blast furnace or other gas is available for burning, the gas turbine comes into its own, and power and blowing requirements in steel works are probably the most immediately attractive industrial outlets for this new prime mover.

Steel works are in general notoriously deficient in good cooling water supplies and a low pressure-ratio gas turbine, using blast furnace or coke oven gas as fuel,



(*Reproduced by courtesy of "The Engineer"*)

FIG. 42.—*Arrangement of gas turbine-driven blower for blast furnace*

with an efficiency at least as good as a steam turbine, can be installed and can be completely independent of cooling water, except that required for oil cooling.

As an example of an industrial gas turbine layout, Fig. 42 shows a unit designed to burn blast furnace gas coupled to a centrifugal blast furnace blower. Such an installation compares favourably in efficiency with a steam turbine driven blower, and the normal blast characteristic requirements are completely satisfied. An

attractive alternative which has now been developed dispenses with the centrifugal blower and adequately meets normal blast requirements by a suitable design of axial flow compressor, supplying at once the air for combustion and, by suitable tapping at an intermediate stage, that for the blast furnace.

When we consider the application of the gas turbine to marine propulsion, the economics are in some ways simplified and in others made more obscure. Oil is universally available to sea-going vessels, and so the problem of coal *versus* oil hardly arises, since even for steam-driven ships oil is now very largely used.

The real problem here is the type of oil which can be burned in a gas turbine installation. If the oil is residual, then obviously the gas turbine need only compete in efficiency of operation with the steam boiler and steam turbine. If it is distillate, then it must compete with the diesel engine. We *know* the gas turbine will operate successfully on distillate fuel. We have good grounds for thinking that owing to fouling of the turbine, it will not at present run for sustained periods on all types of residual. We are referring, of course, to the open cycle unit. At present we are unable to say whether residual oils can be burned successfully in a closed cycle air boiler.

In common with a steam turbine driven ship, in order to secure speeds of propeller revolution which will give efficient propulsion, some form of reduction, gear must be interposed between the gas turbine unit and the propeller. This in both cases may take the form of reduction gearing in conjunction with an astern turbine, hydraulically operated clutches, or a controllable pitch propeller. Alternatively, electric transmission may be used. The gas turbine does not readily lend itself to the fitting of a reversing turbine and so one of the three remaining alternatives must be used.

In such respects turbines, be they steam or gas driven, are at a disadvantage both in regard to speed and ability to reverse, in comparison with the diesel engine, which can be directly coupled to the propeller, can be reversed (albeit with some difficulty in large sizes) or can, of course, rotate unidirectionally direct-coupled to a variable pitch propeller. It suffers limitations as to cylinder dimensions and for large powers becomes unduly bulky and heavy, but in cargo vessels of up to 5,000-6,000 s.h.p., owing to the high efficiency and high degree of reliability of the diesel, the gas turbine may not find a very fruitful field for invasion. More particularly will this be so, if the success so far attending trials carried out by the Anglo-Saxon Petroleum Company on the diesel-electric tanker *Auricula* using low-grade boiler oil, is confirmed by extended running.

It would appear, therefore, that the most attractive outlet for the gas turbine in the marine field lies in its application to the higher-powered cargo ships, to passenger liners, and to naval vessels.

In considering the type of gas turbine installation best suited to marine propulsion, we may in the first instance divide the possible solutions into two broad categories:

(*a*) a variable speed turbine unit in which the speed and load are tied and vary in accordance with the cube law of the fixed pitch propeller; and

(*b*) a variable speed turbine unit which allows of a speed independent of the propeller load.

A unit with A.C. electric transmission or a geared unit with hydraulic manœuvring clutches would satisfy category (*a*) and a geared unit with D.C. electric transmission, with variable pitch propeller, or with constantly coupled hydraulic clutches, would satisfy category (*b*).

Essentially category (*a*) requirements can best be met by a two-line arrangement with a work turbine capable of operating at a speed independent of that required by the compressor load. The torque of a single line unit would in general be adequate for normal operation, since the torque as shown in Fig. 35 would be adequate to meet the propeller torque, varying as it does directly as the square of the shaft speed. But under many circumstances it would be necessary and often convenient to develop a greater torque, and in this case a two-line arrangement would be desirable and control would be much more flexible. The choice of A.C. transmission or of gearing with hydraulically operated manœuvring clutches, depending as it does on a large number of circumstances, cannot be arbitrarily decided and is likely to provoke the same difficulty of choice as exists in the case of steam turbine driven vessels.

With regard to category (*b*) any one of the alternatives cited above may be used in conjunction with a single-line gas turbine unit. All the schemes are, however, difficult for one reason or another: hydraulic clutches on the score of efficiency, D.C. transmission on cost, and variable pitch propellers on inefficiency and incomplete development. Accordingly, immediate applications are likely to be multiple-line arrangements with stage intercooled compression, reheat and heat regeneration, in conjunction with either A.C. transmission or hydraulic manœuvring clutches with gearing.

A suitable arrangement for a marine unit of the order of 10,000 s.h.p. might consist of the layout shown in Fig. 41 or 30 (*c*) in conjunction with an A.C. electric transmission, of the type designed and manufactured, for example, by the authors' firm and installed in the C.P.R. " Beaver " class turbo-electric cargo liners. These particular installations have been described in a recent paper* which also illustrates and describes a gear-cum-hydraulic clutch arrangement which would meet the requirements for the alternative direct coupled drive referred to above.

The performance of the turbo-electric driven " Beaver " liners described in the above paper, is indicative of what may be expected from an up-to-date marine steam turbine unit, and it is against such a performance that the gas turbine possibilities must be judged. The average fuel consumption on the *Beaverglen*, on her third voyage from Montreal to London, for an average output throughout the voyage of 9,010 s.h.p. was 0·520 lb. per s.h.p. hour—equivalent to an efficiency of some 25·76 per cent.

This approximates closely to the efficiency we may expect from a gas turbine with a "life" in any way approximating to that of the steam turbine installation, and so the question of the use of steam or gas turbines for merchant shipping will be decided upon considerations of first cost, space and weight, maintenance and the type and cost of the oil fuel used.

Lastly, we will consider briefly the application of the gas turbine to main line

*A. W. Davis. North East Coast Institution of Engineers and Shipbuilders. November 18th, 1946.

locomotives. The field seems at first sight promising, since in spite of all the improvements which have been built into it, the efficiency of the wheels of a steam locomotive seldom exceeds 12 per cent. and is usually coniderably below this figure. Having regard to the effect of space factors on the thermal ratio obtainable from the heat exchanger, the size and hence the pressure drops in the gas and air ducts, and the temperature limitations imposed by long life and reliability requirements, the locomotive gas turbine may have a shaft efficiency of the order of 20 per cent. and, depending upon the type of transmission employed, an efficiency at the wheels of some 16 per cent.

But before judgment can be pronounced on its possible economic large-scale application, answers must be provided to a number of searching questions. What, in comparison with the reciprocating steam locomotive, is its first cost; what fuel does it use; what is the cost of the fuel in comparison with coal; what is its availability; what its reliability; how does its maintenance compare and how does it compare in first cost, efficiency, reliability, availability, and upkeep, with a diesel-engined locomotive; what form of transmission does it use?

It is not possible within the scope of this short paper to attempt a critical analysis of the replies to these pertinent questions, nor would it in fact be possible, with the very limited data on gas turbine driven locomotives available at present, to make such an analysis more than a paper study. We may, however, consider some of the more general aspects of the problem.

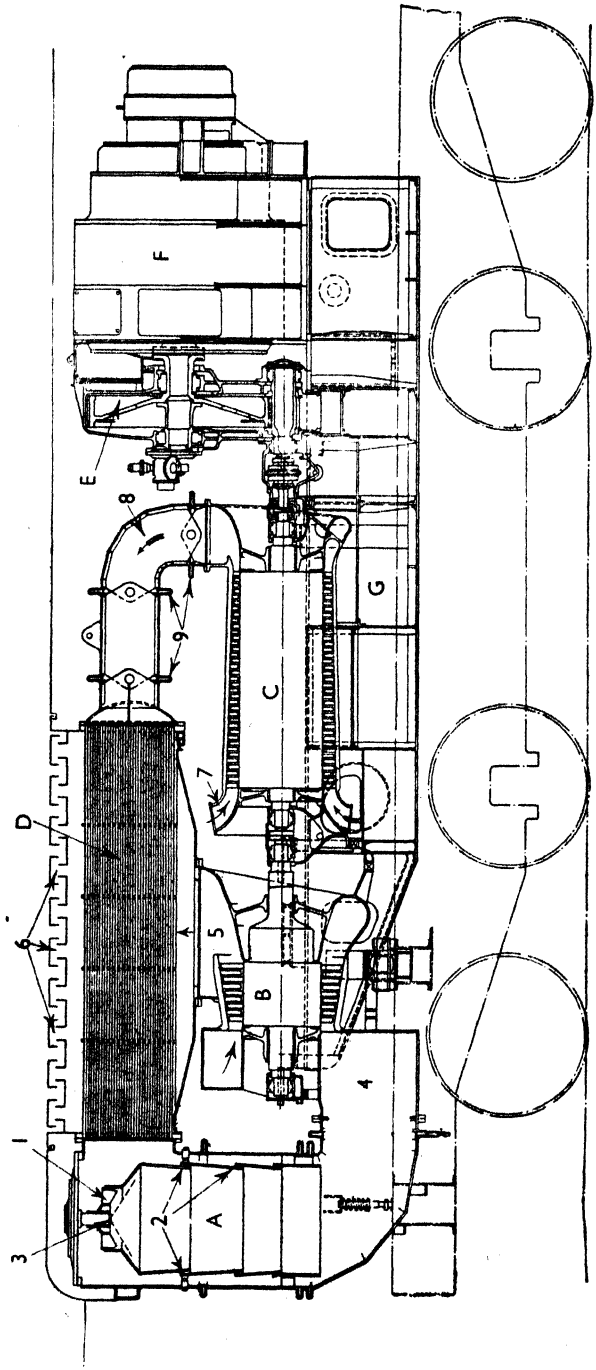
In the first place, the initial cost of the gas turbine driven locomotive is likely to be less than that of a diesel driven but will certainly be very much more than a reciprocating steam-engine driven locomotive. The latter is notoriously cheap in comparison with alternative types, due in the main to the fact that the prime mover is simple in construction and can be direct-coupled to the driving wheels. On the other hand the gas turbine must be coupled through gearing or through gearing and an electric drive, the former method being applicable to a separate power turbine unit, the latter to a single-line unit.

As mentioned previously, the torque characteristics obtainable with a separate power turbine allow of a relatively simple gear train to the driven member. Even so, for horse-powers of the order of 2,000 to 2,500 which must be considered, the design of the necessary clutch mechanism, be it mechanically, hydraulically or electrically operated, and the power coupling to the driving wheels is difficult; the gearing, designed throughout as it must be to take the stall torque, is relatively bulky and heavy. Electric drive usually takes the form of a variable speed D.C. generator running at a speed proportional to its output, and supplying the D.C. driving motors, coupled to the driving axles. Illustrative of this latter type, Fig. 43* shows a section through a gas turbine unit for a locomotive designed and built by Messrs. Brown Boveri for the Swiss Federal Railways.

Either type of transmission, mechanical or electrical, provides the necessary torque-speed characteristics, but each involves expensive components compared with the simple robust and reliable coupling of the reciprocating steam engine.

Before the war the relative costs of oil and coal would have made the invasion of

Proceedings of the Institution of Mechanical Engineers, Vol. 150, No. 1, 1943. Adolph Meyer, " The First Gas Turbine Locomotive."



(*Reproduced by courtesy of "Engineering"*)

FIG. 43.—*Section through locomotive gas turbine unit*

A. Combustion chamber.
B. Gas turbine.
C. Compressor.
D. Air heater.
E. Gear.
F. Generator set.
G. Bedplate of unit.
1. *Swirl vanes.*
2. *Slits.*
3. *Injection nozzle.*
4. *Mixing space.*
5. *Exhaust gas inlet to air heater D.*
6. *Exhaust gas from air heater D to atmosphere.*
7. *Air inlet.*
8. *Air outlet pipe.*
9. *Expansion joints.*

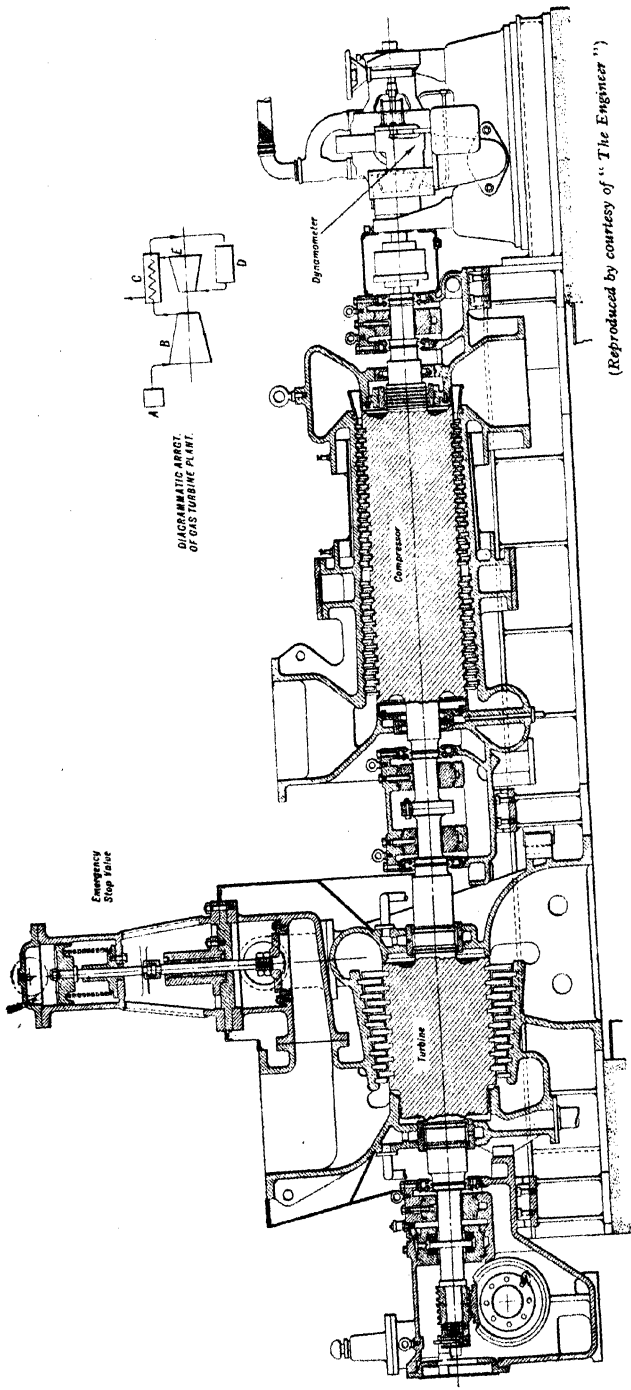
the gas turbine in the locomotive field an economic impossibility in this country, but the present price of coal sets a premium on efficiency, and were oil not more than thrice the cost of coal on a weight basis the running costs of the steam and gas turbine driven locomotives might work out roughly equal on a purely calorific basis. In view, however, of the lower handling costs and relative cleanliness of oil, the low lubricating oil consumption of the gas turbine plant, the ash handling and water supply and water treatment problems associated with the steam engine, and the fact that the gas turbine driven engine can be operated by one man, it must be obvious that the true running cost comparison is not simply a question of relative fuel costs. Oil can in fact carry a fairly heavy burden in cost per ton compared with coal and still pay dividends. There is still considerable doubt however as to the type of oil that can be successfully burned in a gas turbine. If, to avoid ash deposits, it must be distillate, then competition from the diesel-engined unit will undoubtedly be severe, and any large-scale use of either, a matter of some considerable doubt.

It will be understood, of course, that the above remarks apply in the main to countries like England, rich in coal and poor in home-produced oil. Without doubt, in countries where oil is produced plentifully and cheaply, and in which there are difficulties associated either with supply or quality of water, the gas turbine driven locomotive has wide and immediate possibilities of application. To a lesser extent an immediately economical field of application is to be found in those countries which are forced to import both coal and oil.

From these and previous observations, it is clear that in so far as England is concerned, before it can take the place in industrial applications, which its inherent simplicity and efficiency demand, the gas turbine must be designed to burn coal—preferably in the open cycle. While the difficulties associated with this are not to be minimised, recent developments in pulverisation, vortex dust separation and vortex burners, are being brought to bear on the problem and in the U.S.A., where the resources of the Locomotive Development Commission, Baltimore, Md., are being concentrated on the subject, some considerable success has already attended the application of these principles to the burning of coal in an open cycle locomotive gas turbine.

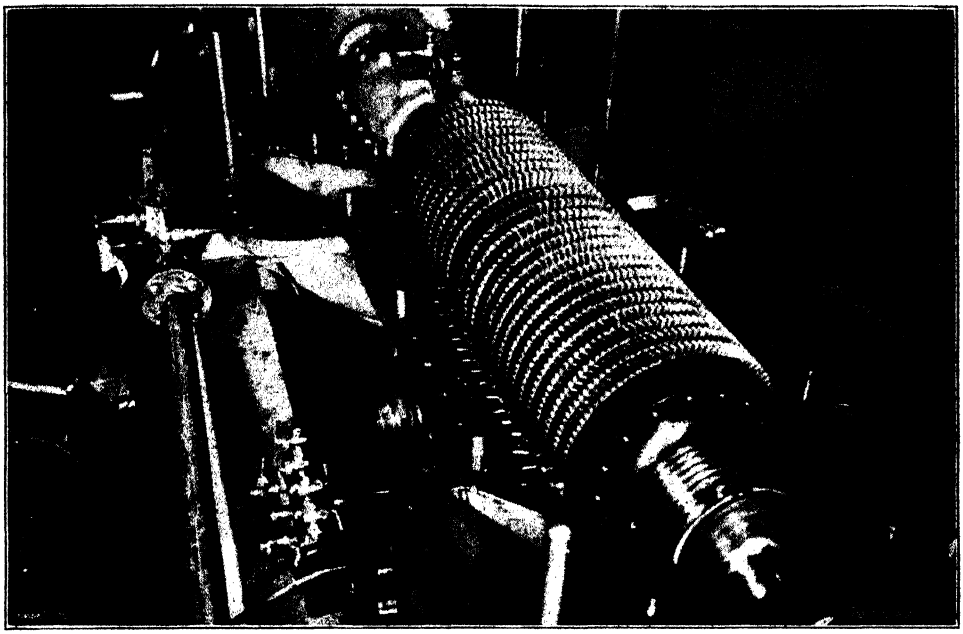
And on this note we may conveniently bring our paper to its conclusion. A glance into the future is always held to be a fitting end to a paper; and stated in the simplest terms the future of the gas turbine in industry depends largely on its ability to use directly our national source of wealth—coal. Until that stage of its development has been completed—and it will be completed in due course—many useful outlets are, as we have seen already, economically available to this new and lusty prime mover. The experience gained in the use of high strength heat-resisting materials will act as a spur to further developments in the steam turbine and so a vigorous and healthy competition may confidently be anticipated.

Perhaps we may be allowed to end on a somewhat personal note. Just before leaving England in 1931, on what was to be his last voyage, and just as he was leaving the works for the last time, Sir Charles Parsons told the Chief Research Engineer, the late Dr. Robert Dowson, that he thought he had the solution to the problem of the gas turbine and that he intended to spend his time on the voyage



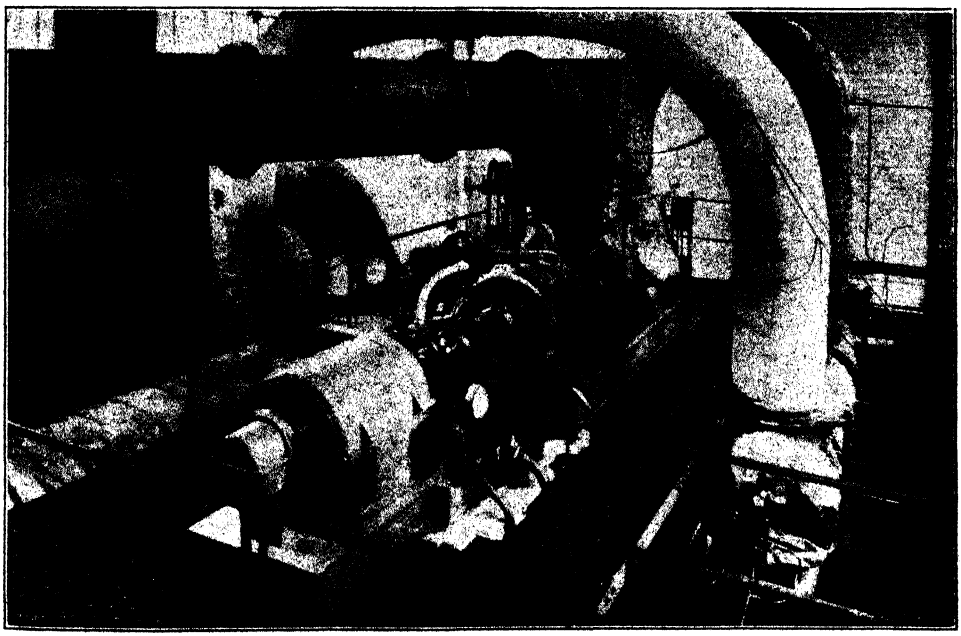
(Reproduced by courtesy of "The Engineer")

FIG. 44.—*Section through 500 h.p. experimental gas turbine plant*



(*Reproduced by courtesy of "The Engineer"*)

FIG. 45.—*Axial compressor with cover removed*



(*Reproduced by courtesy of "The Engineer"*)

FIG. 46.—*General view of gas turbine plant*

working it out in detail. What his solution would have been must remain unknown, but without doubt, knowing his intellectual stature, it would have been an invaluable contribution to our knowledge on the subject. It is perhaps a fitting tribute to the pioneer of steam turbine development, that the Company he founded should have energetically engaged on gas turbine development and should have produced in collaboration with the Parsons Marine Steam Turbine Company, Ltd., what is, as far as the authors are aware, the first (albeit small), commercial type gas turbine in England.

Some particulars of the unit, described in some detail in *The Engineer* July 19th, 1946, are shown in Figs. 44 to 46. We hope in the near future to be able to say something of the operating experience we have obtained in over a year's working of the plant.

ACKNOWLEDGMENTS

The authors wish to acknowledge the invaluable assistance of Mr. G. Arkless, Assistant Research Engineer, and Miss M. Christie, Technical Assistant, in the preparation of the curves and diagrams contained in the paper.

DISCUSSION

THE CHAIRMAN: I congratulate the authors of this paper on a particularly fine production which, I am sure, when printed, will be full of interest and information and of very great value to all who are concerned with gas turbine development.

Before calling for a general discussion of the paper I should like to make a few remarks with some emphasis on the application of the gas turbine to naval work. Those remarks will be brief and very general. Firstly, however, I should like to say how fitting it seems that we should have had this opportunity of hearing a paper read by authors associated with a firm which bears the name of that outstanding engineer and personality, the late Sir Charles Parsons. The authors refer in their paper to Sir Charles' remarks shortly before his death. It is indeed sad that this country should have lost his invaluable advice and services at that time, and we can only conjecture what his contribution would have been; it might well have been such as to put this country in the forefront of progress in this particular field of development.

We in the Navy are taking the greatest interest in the possible application of the gas turbine to marine propulsion and are devoting considerable effort to this purpose. The authors have discussed the commercial applications in this field and have pointed to some of the difficulties, many of which are related to the connection between the power unit and the propeller. These remarks apply also to the naval application; and in addition we have our special problems, which vary considerably with the type of vessel under consideration.

I will refer to two specific and greatly different cases: the light craft of the motor torpedo boat type and the larger ships of the fleet, in whatever future shape these may appear. In the former case the requirement is for an engine of light weight, compact, simple in operation and maintenance, and capable of rapid construction in considerable numbers. A moderate life between overhauls can be accepted. Good efficiency over a considerable range of boat speed is a necessity, and for this reason the simple type of cycle does not meet the need. The restriction of space makes difficult the application of heat exchangers, though successful development of the regeneration type would undoubtedly help. The rival in this type of craft is the internal combustion reciprocating engine, possibly associated with an exhaust gas turbine.

In the larger ships the rival is undoubtedly the steam turbine; and, although I have no wish to put myself among the prophets, I feel it likely that this will be so for some time to come. In this class of ship good efficiency over a range of speed, reliability and

reasonably long life are essentials. We are, however, handicapped as compared with commercial applications by the ever-present need for conserving weight and space; and it is clearly evident that much research, development and trial is necessary before we shall be able to accept a design of gas turbine installation suitable to meet our exacting needs and our high power requirements. Another problem, which is really one for the ship rather than the engine, is the difficult problem of making suitable provision for the supply of the large amount of air required and for the disposal of the exhaust gases.

To conclude my remarks I should like to stress the need for co-ordination of effort in all research and development work. Much effort is now being expended in this country on gas turbines and their associated problems. There is a limit to the amount of talent available—the quality is there but the quantity is short. It is surely therefore to the advantage of all and of the country as a whole that the greatest possible degree of collaboration should be the aim.

There is one question I should like to ask the authors in connection with combustion chamber problems. What rate of heat release is practical in combustion chambers lined with firebrick or some other protective material, and to what extent is this influenced by the type of oil used?

Dr. A. T. BOWDEN: The rate of heat release will be determined by the type of ceramic lining used. With the modern types available, providing we can get freedom from spalling and can get thermal conductivity of the right order, there is no reason why we should not be able to get heat releases of the order of 750,000 to 1,000,000 B.T.U.'s per cubic foot. Naturally the heat release will be determined very largely by the type of oil used; but at the present time there is no wealth of information available as to what types of fuel can be used, even in steel lined combustion chambers, and the problems there are much simpler compared with the effects of fuel on a firebrick-lined combustion chamber. But it may be that the firebrick does have a beneficial effect. We have some reason for thinking, if war-time experience of firebrick lined boilers is any guide, that in connection with some of the most dangerous constituents of oil fuel, firebrick may be beneficial. We ourselves have had no experience in burning other than "Pool" fuel in steel lined combustion chambers, although we do propose later on to carry out work on fuels with higher ash contents. Our experience is limited to steel lined chambers and anything we can say is only conjecture, but I think that provided the constituents do not have a deleterious effect on firebrick we should reasonably expect to have heat releases of the order stated.

Mr. H. R. LUPTON (Metropolitan Water Board): I should like to ask three questions. The first is that the gas turbines I have been interested in are of about 2,000 kW. only, and are to be used for stand-by purposes only. Efficiency is a very secondary consideration. I should like to know whether a simple gas turbine can compete with its alternative, the diesel engine, for these purposes (and not for load-relieving, for which a high efficiency is necessary). We visualise turbines with an efficiency of 16 or 17 per cent. when driving alternators.

The second question is this. What maximum temperature of admission to the gas turbine can be relied upon as safe for use over a very long period of years? I noticed in one of the authors' diagrams a figure of 1,258°F. for a closed cycle turbine. Is it safe to use 1,250°F. for a permanent plant which must always be relied upon for power station use, either for prolonged continual running, or for occasional stand-by use over a period of years? I am not interested in the closed cycle for stand-by purposes.

Thirdly, the lecturer made a number of remarks on the competitive value of the gas turbine for large power-station use. What is the comparative ceiling thermo-dynamic efficiency of the gas as compared with the steam turbine? We know that for the steam turbine of the largest size there is a ceiling of something like 51 per cent. It would seem that the corresponding ceiling for the gas turbine with closed cycle, at any rate with re-heating, inter-cooling and heat exchanger, is something more of the order of 72 per cent. for temperatures of 1,258°F. such as were envisaged. If the ceiling is really 72 per

cent. and the steam turbine is about 51 per cent., it would seem that the gas turbine should have a rosy future for power station purposes.

Dr. A. T. BOWDEN: In reply to the first question I should say that the gas turbine is ideally suited to the requirements of stand-by plant of the order of 2,000 kW. with an efficiency of 16 to 17 per cent. That means that one could practically dispense with cooling water, apart from the requirements for oil cooling, and one could dispense with the heat exchanger. This is just the type of requirement that the gas turbine can adequately and cheaply meet.

With regard to the maximum operating temperature, everything one says at the present time must be in the nature of an intelligent guess, because the work done up to now on the creep properties of the materials only covers a running time of probably less than 20,000 hours. Therefore any safe working period in excess of that must be on the supposition that the material is going to behave comparably with its behaviour up to that point. We ourselves feel that in the light of present knowledge 1,200°F. is a reasonably safe temperature for a long life such as we require in commercial units.

With regard to the use of the gas turbine for large power-station units, we have dealt with this question in some detail in the paper. Probably units of up to 30,000 kW. can be designed on an open cycle, by using stage compression, intercooling and re-heating.

What the ceiling temperature of the gas turbine is is very difficult to say, but temperatures of the order of 1,200°F. are those in which we are particularly interested at the present time in long life machines. It is no use talking of temperatures very much in excess of this, and with temperatures of this order the efficiency of the unit is going to depend upon the amount of regeneration of heat. As Sir Claude Gibb mentioned in the lecture, we must look to something like the regenerative heat exchanger with a thermal ratio of 85 to 90 per cent., in order to enable the efficiency of a machine with 1,200°F. maximum temperature to reach an efficiency of the order of 35 per cent. I should say that the average efficiency one might expect with 1,200°F. in a very large power turbine would be of the order of 28 to 29 per cent. under reasonable conditions. I do not know whether that answers the speaker's question completely?

Mr. H. R. LUPTON: Yes, but by "ceiling" I meant "ideal".

Dr. A. T. BOWDEN: The ideal would be of the order of 70 per cent.

Major CADMAN: I should like to ask whether our investigating teams in Germany found the Germans had made any progress in the development of the gas turbine.

Dr. A. T. BOWDEN: I went to Germany twice to investigate the development of the gas turbine, and from the point of view of materials I think I am safe in saying that they had nothing comparable to the materials available in this country. What they lacked in materials, however, they made up in ingenuity, and their development of air-cooled blades will be of considerable use to us in this country.

On industrial applications very little had been done, but one firm in Mannheim had made a blast furnace blowing unit which aroused world-wide interest in that it utilised an axial flow compressor both for blowing and for combustion. My firm has recently done a considerable amount of work on this same subject, and there is no doubt that this forms one of the most immediately valuable outlets for the gas turbine. Its application to blast furnace blowing is a development of the plant shown in Fig. 42, in which a gas turbine drives a centrifugal compressor. That was one of the most outstanding examples of German ingenuity. They, of course, derived great benefit from their association with Swiss firms, which had done more work than we had on this subject prior to and during the war. We are making up for lost time now.

Mr. R. W. CORBITT: I should like to ask why the rotary heat exchanger is divided into two equal areas. One would expect them to be in proportion to their areas.

Dr. A. T. BOWDEN: Normally, regenerative heat exchangers *are* divided into two unequal areas. That we showed in Fig. 33 was only diagrammatic. We are now at a stage when we can say that the mathematics of the equally divided heat exchanger have been worked out, but the mathematics for unequal areas are extremely complex and have not been solved yet.

Mr. T. A. BENNETT: Apart from the question of the 28 per cent. efficiency, which has been dealt with, I should like to know for how long these machines have to run on an electric motor when they are started, and how long it takes them to reach full temperature.

Dr. A. T. BOWDEN: This is a very vexed problem, depending on the type of construction used. With a disc construction the starting time is quicker than with a solid rotor. If we use a solid motor in austenitic steel the temperature stresses are very high, owing to the high co-efficient of expansion of the steel and its relatively low thermal conductivity. If you were to ask the steel maker how long it should take to heat up a solid austenitic rotor he would probably say 12 hours! But one need not use a solid rotor. In fact, we shall probably be forced into using a built-up rotor, and until we have experience in this country of the starting up of such types it is very difficult to say what the starting time will be. In Switzerland one sees gas turbines started up in ten minutes. Well, we have done the same with steam turbines on occasion, but it is not the sort of thing one likes to do, and I think the probable time will be intermediate between the ten minutes in Switzerland and the twelve hours of the steel maker.

Mr. G. B. R. FEILDEN, M.A., A.M.I.MECH.E.: The paper has pointed out very clearly the advantages which accrue from an increase in maximum cycle temperature in a gas turbine. The possibilities of achieving this by the use of improved materials have also been considered.

A method of increasing the maximum cycle temperature without the use of new materials has recently been announced in the shape of the Brown Boveri "pressure exchanger". It appears that in this device the first part of the expansion takes the form of controlled supersonic impulses which reduce the gas temperature to a value which existing materials will withstand.

The advent of the pressure exchanger appears to give promise of improvements in the efficiency of future gas turbines, and I should be very interested to hear any comments which the authors may care to make on this development.

Dr. A. T. BOWDEN: The speaker is referring presumably to the "Comprex" or pneumatic ram developed by Messrs. Brown Boveri. I have no knowledge of this other than what I have read in the patent specifications and technical press, and cannot therefore be very helpful in this regard.

THE CHAIRMAN: Ladies and Gentlemen, I should like, on your behalf, to thank the authors for their paper, for reading it so well and producing such an interesting discussion.

Major W. H. CADMAN, M.B.E., B.Sc., F.R.I.C.: Before we break up, it is my pleasure to propose a hearty vote of thanks to our excellent Chairman, Admiral Maxwell. He has come all the way from Bath to be present to preside this evening.

It has been said that more hot air has been spoken about the gas turbine than has ever come out of it. That may be true elsewhere, but not at the Royal Society of Arts. I am quite sure that when this paper is printed in the *Journal*, with its excellent diagrams and illustrations, it will prove to be a classic on this subject for many years to come.

I ask you to show in the usual way your appreciation of the Admiral for presiding to-day.

The vote of thanks was carried with acclamation, and the meeting then terminated.

GENERAL NOTE

THE CADMAN MEMORIAL MEDAL.—It has been announced that the Cadman Memorial Medal of the Institute of Petroleum has been awarded this year to Mr. Robert Price Russell, a President of the Standard Oil Development Company, the central technical and research organisation of the Standard Oil Company, U.S.A.

The medal was instituted to commemorate the great services to the science of petroleum rendered by the late Lord Cadman. It is awarded for outstanding contributions to petroleum technology or hydrocarbon chemistry, and the recipient delivers the Cadman Memorial Lecture of the Institute of Petroleum as a condition of the award. This lecture is upon a subject related to those for which the award is made. This year's Cadman Memorial lecture will be delivered in June, at the Royal Institution. In this connection it may be noted that the Cadman Memorial Lecture of the Royal Society of Arts is to deal in a similar manner with subjects associated with coal and coal-mining, with which Lord Cadman also had a long and notable association. The first Cadman Memorial Lecture of the Royal Society of Arts was delivered on March 19th, when Professor Douglas Hay, of the National Coal Board, spoke on "British Coal Mining and the Industrial Revolution".

Mr. Russell, the recipient of this year's Cadman Memorial Medal, made a considerable contribution to the Allied cause during the war, by the research and development work which he directed. This included work on high-octane aviation fuels, synthetic rubbers and toluene for explosives; on smoke generators, incendiary bombs and flame throwers. In recognition of this work he was awarded the Medal for Merit, the highest civilian award in the United States. In 1944, he came to this country as Chairman of the Petroleum, Chemical and Rubber Division of the U.S. Strategic Bombing Survey, and headed a team of scientists who followed the Allied troops into Germany to survey the enemy's oil chemical industry.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, MARCH 31..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. A. N. D. Kerr, "**Developments in Fractional Horse-Power Motors.**"

Engineers and Shipbuilders, N.E. Coast Institution of, at the Cleveland Scientific and Technical Institution **Middlesbrough.** 6 p.m. Sir Lawrie Edwards, "**The War Effort and Organization of British Ship Repairing 1939-45.**"

Geographical Society, Royal, S.W.7. 8 p.m. Hon. C. L. A. Abbott, "**Australia's Frontier Province.**"

TUESDAY, APRIL 1..Electrical Engineers, Institution of, at the Electricity Department, **Leeds.** 6 p.m. L. S. Atkinson, "**Modern Electric Lift Practice.**"

At the Cavendish Laboratory, **Cambridge.** 6.30 p.m. D. C. Espley, E. C. Cherry and M. M. Levy, "**The Pulse Testing of Wide-Band Networks.**"

At the Engineers' Club, **Manchester.** 6 p.m. M. J. Marchbanks, "**Coreless Induction Furnaces.**"

Hull Chemical and Engineering Society, at the Church Institute, **Hull.** 6.30 p.m. W. A. Bristow, "**Low Temperature Carbonisation.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester.** 6.30 p.m. James A. Rogerson, "**Some Early History of the Bridgewater Canal.**"

WEDNESDAY, APRIL 2..Civil Engineers, Institution of, at the Engineers' Club, **Manchester.** 6.30 p.m. F. N. Sparkes, "**Some Defects in Concrete Roads; Causes and Remedies.**"

THURSDAY, APRIL 3..Town and County Planning Association, 28 King Street, W.C.2. 1.15 p.m. Mr. E. Antrobus and Mr. Edward Fryer, "**Planning London's Traffic.**"

TUESDAY, APRIL 8..Kinematograph Society, British, at 16 St. Mary's Parsonage, **Manchester.** 10.30 a.m. R. Pulman, "**Auditorium Requirements in Sound-Film Presentation.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester.** 6.30 p.m. Lt.-Col. Sidney W. M. Whitehead, "**War Time Wanderings.**"

WEDNESDAY, APRIL 9..Electrical Engineers, Institution of, at the Heriot-Watt College, **Edinburgh.** 6 p.m. P. Schiller, "**Comparisons between Gas and Electricity on the Basis of Coal Economy.**"

Petroleum, Institute of, at Manson House, 26 Portland Place, W.1. 5.30 p.m. Dr. H. Steiner, "**Aromatics from Petroleum.**"

THURSDAY, APRIL 10..Aeronautical Society, Royal, at the Institution of Civil Engineers, W.1. 6 p.m. C. E. Fielding, "**A Review of Production Difficulties in Relation to Aircraft Design.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. C. T. Melling, "**Commercial Development of Electricity Supply as a Consumer Service.**"

At the Engineers' Club, **Manchester.** 6 p.m. H. Davies, "**The Design of High-Fidelity Disc-Recording Equipment.**"

At the Faraday Hall, St. Austell, **Cornwall.** 6 p.m. J. H. Savage, "**Localization of Faults in Low-Voltage Cables with special reference to Factory Technique.**"

Illuminating Engineering Society, at the Reynolds Hall, College of Technology, **Manchester.** 6 p.m. W. J. Wellwood Ferguson, "**Lighting in Coal Mines.**"

FRIDAY, APRIL 11..Dyers and Colourists, Society of, at St. Enoch Hotel, **Glasgow.** 7 p.m. Dr. G. L. Royer, "**The Application of Microscopy to the Textile Field.**"

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. (1) Professor F. V. Warnock and J. B. Brennan, "**The Tensile Yield Strength of Certain Steels under Suddenly Applied Loads.**" (2) A. F. C. Brown and R. Edmonds, "**The Dynamic Yield Strength of Steel at an Intermediate Rate of Loading.**"

Paper Makers' Association, at the Engineers' Club, **Manchester** 7 p.m. "**From Press to Reel End.**"

Textile Institute, **Manchester** 1 p.m. C. Garrett, "**The Bleaching and Subsequent Dyeing of Jute Fabrics**"

SATURDAY, APRIL 12..Interplanetary Society, British at the Science Museum, S.W.7. Lionel Gilbert, "**Cosmic Rays**"

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

ORDINARY MEETINGS

WEDNESDAY, APRIL 16TH, at 5 p.m.—"ECONOMIC RECONSTRUCTION"—(vi) "PRODUCTION". By the Right Hon. Oliver Lyttelton, D.S.O., M.C., M.P. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Society, will preside.

WEDNESDAY, APRIL 23RD, at 5 p.m.—"ELECTRICITY IN THE HOME". By Miss Caroline Haslett, C.B.E., COMP.I.E.E., Director, Electrical Association for Women. H. T. N. Gaitskell, C.B.E., M.P., Parliamentary Secretary to the Ministry of Fuel and Power, will preside.

DOMINIONS AND COLONIES SECTION

TUESDAY, APRIL 15TH, at 2.30 p.m.—"SOCIAL WELFARE IN THE WEST INDIES". By T. S. Simey, Professor of Social Science in the University of Liverpool. Sir Hubert Young, K.C.M.G., D.S.O., formerly Governor of Trinidad, will preside.

THE HISTORY AND AIMS OF THE ARMY CADET FORCE

By Major-General R. E. URQUHART, C.B., D.S.O.

Lately Director Territorial Army and Army Cadet Force

Peter Le Neve Foster Lecture

Tenth Ordinary Meeting, Wednesday, February 5th, 1947

Major-General The Right Hon. Viscount BRIDGEMAN, C.B., D.S.O., M.C., *Chairman, Army Cadet Force Association,* in the Chair

THE CHAIRMAN: I have two duties to perform which I propose to do very briefly. The first is to express the appreciation of the Army Cadet Force Association, of which I am Chairman, to the Council of the Royal Society of Arts for suggesting and arranging that this lecture should be given on the Army Cadet Force. As you all know, this is the Peter Le Neve Foster Lecture, established in 1938 as a memorial to Peter Le Neve Foster, who was Secretary of the Society from 1853 until his death in 1879. The family connection with the Society goes back even further, for it was in 1761 that the grandfather of that Peter Le Neve Foster joined the Society, and his direct descendant is here this afternoon and was instrumental in suggesting the subject of this lecture. It may be worth mentioning to this meeting that Peter Le Neve Foster was the Treasurer of the Society when the Society encouraged and helped to organise the Great Exhibition of

1851, and now a meeting is to be held here tomorrow to do the same work in connection with the projected Great Exhibition of 1951. We all wish the Society the best of success in that grand project.

My second task is to introduce to you this afternoon's lecturer, Major-General Urquhart. I do not think we could possibly have got anybody more qualified to lecture on this subject. General Urquhart, as you know, after having commanded the First Airborne Division at Arnhem, became Director of the Territorial Army and Army Cadet Force, and was the first officer to win that position with a title denoting main responsibility to the Army Cadet Force. Only recently he took up an appointment to get back to his old love, the command of a Territorial Army Airborne Division, in London. During the time he was Director of the Territorial Army and Army Cadet Force it was not merely his responsibility to look after the cadets but, like so many other people, he became an enthusiast and I am sure that whatever may be the claims of the Airborne Division on General Urquhart in the future he will never lose the interest which he acquired in the cadets when he was Director. I ought to say now, as I am the Chairman of the Army Cadet Force Association, what a tremendous amount was done in a very difficult time for the Army Cadet Force while General Urquhart was in office. Without any more ado I will now leave him to tell his own story of the Army Cadet Force.

Major-General URQUHART then read the following paper:

THE HISTORY OF THE ARMY CADET FORCE

Records are very sketchy on the early history of the Army Cadet Force and its predecessors in name. Officially the modern Army Cadet Force dates from 1859, but there is no doubt that many boys were enlisted or linked to Volunteer Regiments during the Napoleonic Wars. Records give instances of boys of even twelve years old taking their part in both land and sea battles round about that period. It is probable, therefore, that during the Napoleonic invasion scares of the first few years of the nineteenth century many boys joined the volunteers who came forward to defend our shores.

We have definite evidence of cadets in 1803, and I would like to read to you this extract from the current issue of the Army Cadet Journal. This describes the attendance of cadets at the ceremony of the opening of Parliament by George III on November 22nd of that year:

> "A great concourse of people were assembled in the Park, Parliament Street and Palace Yard to testify their loyalty, by repeated acclamations.
>
> His Majesty's attention was attracted by the sound of drums and fifes, which proceeded from the Royal Juvenile Volunteers, who were stationed on the leads of Mr. Watson's projected shop front, to the number of about fifty, in a blue and gold uniform with small muskets. As His Majesty passed, the drums and fifes played the "Reveille" and the whole Corps saluted His Majesty.
>
> The novelty of the sight of fifty youths, from twelve to sixteen years of age, arrayed in full military uniform, attracted the particular attention of His Majesty. A label was placed in their front, in large letters, 'Ready to succeed our fathers in defence of our King and Country' ".

In 1859, the country was seriously alarmed at the growing power of certain European neighbours, and as a result the Volunteer Corps was formed. Within a very short time about 100,000 men were enrolled. The Corps was supplied by the

Government with arms, but the volunteers themselves paid all other expenses, and even brought their own equipment. Many of the schools formed corps of cadets, and this is the earliest official evidence of actual school contingents.

An interesting sidelight on the times is shown by this extract from an interview which a retired officer, who was writing a Volunteer history, had with Napoleon III. "The Emperor expressed the opinion that he did not think the public schools would join in the Volunteer movement by forming Cadet Corps, because the headmasters of these schools are of the old style and will never favour military exercises". Time has not proved this correct, for the schools then as now are the backbone of the Cadet movement. The Emperor's remark, however, about the attitude of schoolmasters is pertinent, for they obviously have a very influential effect on the popularity or otherwise of the movement.

So far we have only mentioned school units or closed units. There is also evidence that open units were also forming about the same time. We have evidence that in March, 1862, 30 cadets of the Huddersfield Volunteer Battalion, uniformed in red jackets and grey trousers, accompanied their parent Battalion to a review in Doncaster, but were forbidden to take part in it. Their strength is reported by September to have increased from 62 to 65. An early reference to cadets is contained in the second edition of the Volunteer Regulations published in 1863, and this states that cadets were allowed to wear the uniform of their parent Battalion and were administered and officered by it.

In the early days the object of the Cadet Corps was simply to provide pre-military training, and the school units have to a certain extent retained this to-day as their object. In the 'eighties, however, a very strong movement was started to use the cadet organisation as a means of rescuing working boys from the squalor of bad housing, bad working conditions, poor feeding and cheap liquor, all of which were by-products of the Industrial Revolution. It is understood that Manchester can claim the distinction of starting the first Battalion for working boys. The first Cadet Battalion of the Manchester Regiment was raised in 1884, with the initial strength of three officers and forty cadets. By 1900 the strength had increased to 600.

In 1885 a Corps was started in London based on Toynbee Hall in Whitechapel.

In the 'nineties the expansion of the Cadet Force was very great and we find during this period great support given to the movement by prominent people—social reformers, churchmen, politicians and soldiers. At one public meeting in 1893 we get Sir George White, who was then Commander-in-Chief, India, calling attention to the two aspects of the Cadet Force which predominate to-day, the military aspect and the social aspect. He said he "could not imagine any system which would lead to a higher type of life than that of lads coming forward voluntarily to learn self-control and self-discipline", and that this was "a movement for the benefit of working lads of England". This was a social aspect. As regards the other side, the military aspect, he said: "The young lads who have joined the Cadet Corps and afterwards enlisted would prove as useful a leaven to the Army as did the volunteers of Germany. These lads learned the first duty of citizenship, namely the duty of defending the land which gave them birth". Another moving spirit was Octavia Hill, the housing reformer. She realised that the Cadet organisation

would attract boys who would never be interested in any other of the youth movements, and she exerted herself to this end and saw that money and influence were forthcoming.

The South African War naturally caused a tremendous activity in the Volunteer world, and this affected the Cadets also. In the schools the number of contingents increased from 41 in 1898 to 99 in 1902. One open Cadet Battalion, the first Cadet Battalion of the King's Royal Rifle Corps is reported to have sent a contingent to South Africa and it is the only Cadet unit on record to have a battle honour. In 1898 the first Public School Cadet Camp was held, and it is reported that during this Camp the contingents were invited to take part in a "sham fight" at Aldershot held in honour of the German Emperor, Wilhelm II.

In 1901 a special uniform was allowed, consisting of Norfolk jacket of woollen material of a neutral tint, with roll collar and shoulder straps but no facings. The trousers were to be of the same material as the jacket.

It is interesting to note that cadets were in the Mall for Queen Victoria's Diamond Jubilee in 1897 and again formed a Guard of Honour on Constitution Hill for King George V's Coronation. During the first World War, in 1915, there was a record of 8,000 cadets marching past Lord Kitchener in Whitehall and the King at Buckingham Palace.

In 1906 the Territorial Force was formed with the background of the volunteers who did service in the years before. On this date also the Cadet movement underwent an important change. As the result of a War Office Committee, the Officers' Training Corps was formed in two divisions, the senior in universities and the junior in schools. All other cadets continued in school and open units. The term "Cadet Force" came into use and in 1910 it was handed over to the care of the newly-formed Territorial Force Association.

For the next ten years there was steady expansion and, excluding the Officers' Training Corps, we see a growth from 251 companies in 1911 to 2,318 in 1921, representing an increase from 14,000-odd boys to just under 120,000.

Then came the slump, and the War Office ceased to administer the Cadet Force and handed it over, together with an annual grant, to the Council of County Territorial Army Associations. By August, 1928, the number of Companies had dropped to 949, with a total strength of under 50,000. In 1930 the lowest ebb was reached, for official recognition, together with the arms and the capitation grant, were withdrawn altogether. This official attitude, and the action of some education authorities in banning cadets in schools, caused a severe reduction in the number of units and left only a hard core of school and well-found open units to carry on. By the outbreak of the last war the strength of the Army Cadet Force was only about 20,000.

It was during this very lean period that the British National Cadet Association was formed under Field-Marshal Lord Allenby, to keep alive the Cadet movement and to fight for the restoration of official recognition. I will mention this Association again later.

The outbreak of the second World War naturally stimulated interest and during the early years existing cadet units showed their worth and did many useful jobs, particularly in those areas which were subject to heavy air raids.

In 1941 the Government scheme for the registration and training of youth was launched and the Army Cadet Force took a fresh lease of life. In the following year the War Office again took over the administration and substantial benefits, including uniform, were given. The results were immediate. By the end of the war the strength had grown to about 10,000 officers and 180,000 boys.

It might be expected that with the ending of the war and with the interest engendered by it that the Cadet Force would drop away considerably. Some drop in numbers was inevitable, but in many cases it has had a salutary effect in pruning out the weaker brethren and leaving the healthy growth. The present strength is some 9,000 officers and 130,000 boys, which shows that the interest has been well maintained. Naturally there are many counter-attractions, but these have not prevented many contingents from increasing their numbers. Attendances, too, at camp have been encouraging. It is worthy of remark too that during the last year many additional benefits have been obtained and much official recognition given to the value of the Army Cadet Force as a pre-service movement. Much remains still to be done, particularly as regards improving the conditions of service for officers, but, by and large, it is receiving a great deal of official help, much more than ever before.

Army Council Policy

I should like here to give you an extract from the Army Council letter which governs the actions of the Army Cadet Force to-day:

> "It is the intention of the Army Council to frame the military and social activities in such a way as to provide a general introduction to military training while at the same time meeting the demands of youth training in its wider sense.
>
> For these reasons the emphasis of training to Army Cadets will be on fostering and developing qualities of leadership rather than upon securing the attainment of an advanced standard of individual military skill which must in general be acquired after joining the Regular Army or its auxiliary Arms. They have no doubt that this preliminary training will not merely be worth while by teaching the boys of the country the lessons of self-reliance and civic duty, but will be a direct benefit to the Army itself by bringing to notice boys who have natural qualities which will be of value to them and to the Army when they reach non-commissioned or higher rank and by developing these qualities.
>
> Finally, the Council wish to make it clear that it is their intention to continue to give to the Army Cadet Force such material assistance as is possible in the face of other and competing demands upon the nation's resources".

How Does the A.C.F. Compare with Other Movements?

There is really no such thing as a Youth Movement in Britain. There is instead an aggregate of youth organisations. These fall into three main divisions: the pre-service units, the Boys' Clubs and the Boy Scouts and similar organisations. Each organisation is to a certain extent different and an entirety in itself. Each has a discipline and method of its own and makes its own contribution to the development of the next generation. Their ideas and practices vary considerably, yet they all

flourish. Each has its periods of ups and downs, but statistics show that most are increasing, both in numbers and efficiency.

The relationship of the Army Cadet Force and the Boys' Clubs is already well established and there are equal though different benefits which the Army Cadets and the Scouts can give to each other. The one basic factor which remains common to all organisations is that in the long run they all depend on the efforts of unselfish and devoted men. The hard core of all these organisations is the body of leaders who devote their time, thought and energy to those growing up with them. All are making for the same end, to make better citizens. It is well then that we take the trouble and time to study the ways and means of others who are going in the same direction. We must always be aware that the total of all the voluntary services for youth in this country do not touch probably even 50 per cent. of the youth in the appropriate age groups. There is plenty of room for all of them, and nothing but good can come of the healthy rivalry which they engender. Some may be better run than others, and some may in the opinion of interested individuals be conferring greater benefits, but all are pointing in the same direction, namely, the benefit of youth.

The Training of the A.C.F.

As regards the training of the cadet our charter is clear. In peace as in war the object is to give mental and physical training to boys and so form the character of each to enable him to make a good start in life, to develop in him the principles of patriotism and good citizenship, bringing out the qualities of self-confidence and self-respect, and the ability to face and accept responsibilities.

The cadets are organised into platoons, companies and battalions. The size of the unit and of the sub-unit with which the cadet does his training is entirely dependent on the size of the locality in which he lives and the strength of cadets raised in that neighbourhood.

A limiting factor is still unfortunately the availability of officers. Generally speaking, if the officers are found and are of the right quality, then there is no difficulty in attracting cadets. Indeed, there is no limit to the number of detachments that might be raised if the leaders are forthcoming. There are plenty of potential cadets.

We teach elementary drill and discipline, elementary weapon training, and the rudiments of map-reading and fieldcraft. Superficially, the training we give is military in character, but responsibility, self-discipline, honesty and high moral standard, *esprit de corps* and sportsmanship are qualities we must develop. Here is the real task of the pre-service organisation.

Great stress is laid on the value of leadership and we aim to develop this to the limit of our means with the object of helping cadets with their future careers, whether in the Army or in civil life. Apart from the military side the cadet needs club life, games and sports and physical training. A happy balance must be struck. The boy himself must be treated as an individual whose character is being moulded by good leadership. I will discuss the club side further, later.

The very fact that our organisation and training is military should make it easier for us to succeed in our real purpose in the development of character. We must

attempt to make good the deficiencies in those boys whose formal education stops short when they leave school.

We must always remember that the boy who joins the A.C.F. does so for his own pleasure and enjoyment. There is no compulsion, and the boy can join and leave when he pleases. If we are to keep him we must see that he is not disappointed. Later he will acquire feelings of loyalty and responsibility to his unit, and will be prepared to make some sacrifice for it. Consequently our immediate aim must be to satisfy the desires of the junior cadets while fostering and developing unselfish qualities in the older boys.

I have mentioned the classification of open and closed units of the Army Cadet Force. The closed unit is one which is organised and run wholly within a school. The open unit caters for all types of boys and has no particular school affiliation. It is obvious that the two types must differ in certain aspects, and I would like to tell you something of these differences. As some cadet formations and units are made up of companies both of the open and closed variety, these differences tend to loom rather large and sometimes to lose their right proportions.

The school is a relatively small society, very self-contained, very highly organised and very busy. The idea that a day school is concerned solely with the preparation of boys for examinations and that other activities are merely tolerated as a form of relaxation is mistaken. It is a very closely knit community in which games, clubs and societies of all kinds must join with the ordinary school studies to enable its members to take a full share in its life and to prepare them for the world they will enter when school days are over. It is into such a community that the school unit must fit. It must not demand so much of its members that they cannot discharge their other duties as members of the school.

It is when we consider the many and varied activities which come under the heading of Welfare that we find the greatest differences in the relationship between the school and open units in a cadet battalion. These differences have been at times the cause of misunderstanding.

Open units vary considerably in the social and educational standards of their members. They include a proportion of boys who have received a grammar school education, but the majority have left school at fourteen and are at work. For them, welfare is provided to supply what they have missed through leaving school early. It may well be that in some open units the social training is of greater importance than the military. This can never be true of a school company, for it is part of a community in which games and social activities are already developed. The school whose members need the assistance of an external welfare organisation will be a bad school.

Games in units which consist of open and closed companies present the school unit commander with a problem. He must either decline to take part and be suspected of social aloofness or subject his cadets to a divided loyalty, whether they should play for the school or the battalion.

Another main difference is in respect of the relationship between officers and N.C.O.s. In the case of the school unit this is between the master, who is also the officer, and the more senior boy who is also the N.C.O. In the open units there is a more clear-cut distinction and neither officer nor N.C.O. has a dual characteristic

in this respect. In the school you get the curious relationship between the schoolboy corporal and the schoolmaster officer. The boy's code of honour forbids him to report the shortcomings of his fellows to a master. Military discipline requires a corporal to bring defaulters before the officer.

One of the great virtues of pre-service training is that it discovers interests and aptitudes which are revealed by no other school activity, so that boys who are not otherwise prominent in the life of the school rise to positions of responsibility, for the qualities which make a good prefect or captain of games are not always those which fit a boy to be a non-commissioned officer.

THE SOCIAL ASPECT OF THE A.C.F.

I will now deal with the second main characteristic of the cadet life—the social aspect. The background of this side is to a large extent provided by the Army Cadet Force Association, the Chairman of which is this evening's Chairman, Lord Bridgeman. Lord Bridgeman has also held the office of Director-General Home Guard and Territorial Army, the directorate which includes responsibility for the Army Cadet Force, so he is particularly suitable and well qualified for that position.

The Army Cadet Force Association, or as it was known previously, the British National Cadet Association, was, as I have said, formed in 1930 and had as its first president Lord Allenby. It was formed when the Government of the day decided to withdraw the grant and all official help for the cadets. The few enthusiastic officers got together to see what could be done to save as many units as possible.

During the period between withdrawal and the resumption of Government recognition in 1942 the British National Cadet Association was entirely responsible for keeping the Army Cadet Force in being.

The most important work was its fight to get the army cadets officially recognised again.

The B.N.C.A. fulfils its duties by:

(*a*) Acting as advisers to the War Office and to other authorities on Army Cadet Force matters.

(*b*) Fostering the welfare, recreation and club life.

(*c*) Representing the Army Cadet Force in matters not within the province of the War Office, such as dealings with certain civilian organisations connected with youth service.

(*d*) Advising on the religious aspect of the A.C.F.

(*e*) Arranging and administering sporting competitions.

(*f*) Publishing the Cadet Journal.

Many of you may remember the Army Cadet Force Rally which took place last year in Hyde Park. Her Royal Highness Princess Elizabeth took the salute and over 6,000 cadets marched past. This was one of the many activities which was organised by the Army Cadet Force Association. They have too been responsible for organising sports tours to European countries, and quite recently a very successful trip was carried out to Denmark. Other expeditions are, I know, in the planning stage. It is interesting to note the value which is placed on our cadet movement by other countries. Deputations have already visited this country from Denmark and Holland and it is probable that contingents may soon start in those countries.

THE CLUB SIDE OF THE A.C.F.

The club side of the cadet movement began its main development during this last war. At first its claim for recognition had a hard struggle with the more military side of the training, but later and now it has found its place in cadet life.

In the very earliest days those in command were told that military training was not the be-all and end-all of the Army Cadet Force. The Force had at its back the N.A.B.C., who aimed to give the boy training as a civilian through membership of a club, as well as to give him the preliminary military training.

During the first few years of the war, as we have seen, expansion of the Army Cadet Force was rapid and tens of thousands of boys and scores of cadet officers joined. Gradually the Army Cadet Forces settled down and training proceeded on well-ordered lines. But the necessity for forming a club around each unit and working with the National Association of Boys' Clubs was to a certain extent forgotten. Clubs which were affiliated to the N.A.B.C. in all parts of the country did form cadet units as one of their activities, and there are whole battalions to-day who owe their existence to the enthusiasm developed in these Boys' Clubs.

Sometimes a club allowed the cadet unit which began as one activity only in its varied programme to overwhelm it. It ceased to be a club and became a unit. In others, a minority I am glad to say, the difficulties of maintaining a correct proportion between cadet training and club activities were too great and the cadet unit dwindled away. In others unit and club worked harmoniously. Meanwhile, units had been formed in many places in which there were no boys clubs and for the first years they concentrated on training.

At present no-one can foretell how far the boys of post-war years will respond to giving up two or three nights a week and some week-ends to purely pre-service training. It is realised that the pill of training should be wrapped up in the jam of a club and that it will be wise to attract boys by the pleasures of club life.

We agree that a growing boy must be helped to develop all sides of his nature. If too much is concentrated in one direction only, then he will tend to develop wrongly. Take a boy off the street, give him pre-service training for two nights and leave him to the streets for the other five of the week and he will seldom become a really efficient cadet. Moreover, such is a boy's nature that he will quickly tire of training and go back to his street and remain there. A boy needs to experiment and for that he must have variety. Give him other pursuits and a chance to mix with other boys and he will come to his training with a new keenness. These facts are largely recognised in the Army Cadet Force to-day.

The problem is to adjust the rival claims of the Army Cadet Force and the National Association of Boys' Clubs. There is ample and good co-operation on the highest levels, but the main problem of course arises on the ground level where physical contact is made. The A.C.F. and the N.A.B.C. are both concerned with the welfare of boys, but each has its own distinctive technique and the problem is to ensure that they work harmoniously together. Cadet officers of all ranks are, of course, concerned with the welfare of their boys. Some are enthusiastically convinced that pre-service training only is what they need, and these are naturally suspicious of anyone who does anything calculated in their minds to undermine the military

discipline they are trying to instil. Many of them therefore regard the apparently easy-going methods of the club with suspicion.

The club leader and the N.A.B.C. are equally concerned in the welfare of the boy. They are enthusiastically convinced that what the boy needs is to be allowed to develop in the free atmosphere of a club. Many of them therefore regard the rigid discipline of the cadet parade with some suspicion. Between these two enthusiasms stands the boy. The majority of boys are quite prepared to accept both methods and to benefit by them. The difficulties do not lie with the boy. He is quite capable and ready to enjoy being a smart efficient cadet on Monday and being a perfectly free agent in carrying on an argument with his club leader on Tuesday. The boy too, with his clear vision, despises any sort of pose and quickly sees through the man who has to stand on his dignity in order to maintain his position. The difficulties lie rather with the men, club leaders and cadet officers, than with the boys.

The training provided by a good club is as advantageous in many respects as the training in a pre-service unit. This training lies not so much in the activities provided, but rather in the fact that the boys, while knowing that they have a sympathetic leader behind them, feel that they themselves are working out an ordered society in completely natural circumstances where everyone is on the same footing.

The list of differences, I won't call them difficulties, may appear perhaps formidable, but I am convinced that many of them are largely illusory. The clubs and the units are working together, and can be made to work given goodwill on all sides. The cadet club can hold its head high in both the Cadet force and the N.A.B.C. The two sides react on each other. The club member is the better for the modicum of military discipline, the cadet is the better for the experience of the club. Of the two original suggestions, that clubs should form cadet units or that cadet units should form clubs, I think the latter is the best answer.

Conclusion

This has been a brief and rather hurried survey of the Army Cadet Force. I am a convert in its favour and I fancy that many of you here this evening have also sympathies in that direction.

Many things that I have said to you this evening are not new, and there is little that has not been said before and with more emphasis. However, if you go away with even some slight thought for the Army Cadet Force and its objects, then I have fulfilled my task.

I was reading last week the inaugural lecture by the new Chichele Professor of the History of War, Captain Cyril Falls. In his opening paragraphs he said that his career as a military journalist had taught him one great secret—the value of repetition. He said that one need never be bashful about covering the same ground more than once. Anything worth saying once is worth saying several times, and in fact is commonly useless if said only once, even by the most eminent persons. This then is my excuse.

There is no service anywhere that is more worth while than that which contributes towards the wellbeing of the youth of our nation. If we get the youth of to-day right and interested, then we have nothing to worry about in the adult of tomorrow.

DISCUSSION

Lt.-Col. F. G. POOLE, D.S.O., O.B.E., D.L.: I should like to ask the lecturer why he made no mention of the Boys' Brigade, which was formed in 1883. The lecturer also spoke of the Toynbee Hall battalion which was part of the Boys' Brigade in 1891, when I was a Sandhurst Cadet waiting for my Commission. I took over a company from an officer in the Tower, Captain Kindersley. It was then part of the Boys' Brigade and was financed from the Boys' Brigade, then definitely in the Cadet movement. Since then it has broken away. In 1891 the Church Lads' Brigade was also formed and was then in the Cadet movement. The Boys' Brigade broke away, I think, during the last war but one, and the Church Lads' Brigade in about the last 12 years. The lecturer also spoke of the philanthropic aspect of Cadet work, and with this I think we ought to associate the names of Lord Shaftesbury and "Chinese" Gordon. The latter used to mark on a chart at Gravesend where his different boys were serving.

Another point is our relations with other pre-service units. During the period when we had to fight for our existence we made an attempt to get into touch with the Air Force, and now there seems to be very good co-operation with the Air Training Corps. Thus last year I took a party of boys over to Flanders, some of whom were Army Cadets and others from the Air Training Corps, and our relations were very cordial.

Major-General R. E. URQUHART: There is no doubt that the Boys' Brigade is doing extremely well at the moment and I think we should encourage them to the best of our ability to continue. I, for one, see no real advantage in trying to destroy their identity by bringing them into the Army Cadet Force. There is plenty of room for everyone and the more movements of that kind there are the better. There is as yet no attempt to nationalise voluntary youth!

As regards the other pre-service units I can assure the speaker that we have a close tie with the Admiralty and the Air Force. Naturally I have more interest in the Army Cadet Force than in the other two and also I may possibly be dishonestly pleased that they are doing slightly better than the others at the moment.

THE CHAIRMAN: The Army Cadet Force Association is in close touch with the headquarters of the Boys' Brigade and with their leader, Mr. G. Stanley Smith.

Captain A. H. DAVIS: The lecturer said that if a thing be worth saying it can be repeated on many occasions, and I, therefore, have no qualms in making the following remarks.

I think one of the greatest difficulties we suffer from to-day is the lack of publicity. All this has been said before, I know, but would it not be now possible for the Army Cadet Force to obtain more publicity through the Press, and also by posters being placed in public buildings or in similar positions? Now the War is over it becomes increasingly difficult to maintain the interest of Cadets, so that all means should be taken to keep up the impetus of recruiting.

Another matter is the influ of new officers into the Force, and the lecturer specially stressed this point. As one who has been a Company Officer (and who first became a Cadet in 1899) it seems to me that one of our greatest needs is to obtain the younger type of men, who served as officers and non-commissioned officers in the late war, and to induce them to take up commissions in the Force. I know this recruitment has its difficulties too, because so many of them had to break their careers on joining the Army, and now have to pick up the broken threads where they left off.

Then there is the question of welfare. This is an integral part of the whole well-being of the Force, and I feel that this question has not always been given the important place it should have, by Commanding Officers in the organization and running of their battalions. I would like to see in the Battalion Club a place where the Cadets could, in addition to playing games, obtain something of educational value, such as a good library, suitable lectures and demonstrations and other things of that character.

Major-General URQUHART: All the points which the speaker has raised are very

relevant. As regards publicity it can be said that we have put the Army Cadet Force on the map and people at various military headquarters are aware of what to do *vis-a-vis* the Cadets. The D.P.R. at the War Office does all he can to put it over to the Press, but newsprint is limited and a news item has to be something rather out of the ordinary to compete with the latest murder. But the necessity for getting publicity is in all our minds.

The point about officers we have mentioned before. It is rather a big problem. There are signs of some of the younger officers beginning to come forward to help with the Army Cadets. But we have to face facts and what the army officer says is "First I must find a job and then I must find a house". After that he is willing to come and help.

I agree that we must do all we can to enlarge the activities of the clubs and, of course, Commanding Officers require education but the older the officer the less inclined he is to adopt new ideas. But it is coming and will come.

Colonel S. L. BIBBY, O.B.E., County Cadet Commandant of Surrey: I should like to say how sorry we are in the Army and Air Force in losing Major-General Urquhart. A great deal was done for the Army Cadet Force during his term of office, and we are grateful to him for it. I think our troubles now are largely financial. From the point of view of clothing and equipment we now have most things for which we have been pressing, but on the financial side things are still very difficult. The rise in the cost of living has certainly made the capitation grant insufficient, and I think that the War Office should either increase it or pay a great deal more towards the expenses of Camp. Also I think there should be considerably more facilities for free transport. We cannot expect W.D. transport, but we should have much greater powers to hire transport, and without it it is almost impossible to run a Unit. It is also essential, if we are to have good officers, that the terms of service of Army Cadet Force officers should be brought into line with Territorial Army officers.

Major-General URQUHART: Those in the Directorate are fully aware of the problems and are doing their utmost to get them settled. Money is going to be increasingly difficult; but there is a strong movement to adjust the conditions of service for officers. This is largely bound up with the combined Services' Cadet Scheme which is being discussed now and which will embrace all contingents in schools. If this is accepted then the conditions of service for open units will come into line as well.

Mr. ASHLEY LUMLEY: Can the lecturer say something about the technique and the difficulties of dealing with the home influence and parents? I should imagine that a great number of the boys come from homes where prejudice operates. Can he tell us a little about how they are dealt with normally and what is the general result of trying to get boys to go into these clubs? What is the usual reaction of parents?

Major-General URQUHART: I hold up my hands in horror! The War Office, as represented by me, deals with the strictly military side, and I think perhaps the Chairman, as representing the A.C.F.A., the body which deals with welfare, is in a much better position than I am to answer this.

Second-Lieut. E. C. LOCKE: With regard to the question of publicity I think a great deal depends on the officers commanding units. It is all very well to talk about publicity on a national scale, but after all, we are interested in the boys in our own particular areas. Most of us have local newspapers and I think it is up to the officers to see that when their units have any special parade or any special activity of local interest, reports of those items are sent to their local newspaper. We cannot expect their reporters to turn up to everything but we can do our bit by sending the stuff to them. We find in our district that the papers are only too pleased to print such reports. They are read by many local people, who do react to them, and we have obtained recruits by that means.

Another point is that during the war years most units have had the run of the Territorial halls. Now we know that the Territorial Army is coming back. Those of us

who are ex-Territorial Army are pleased, but we are worried about what is going to happen to us. Can the lecturer give us any idea of the position? Shall we have to go back to our school-rooms or shall we still be able to make use of Territorial Army premises?

Major-General URQUHART: The speaker is quite right in what he says about publicity. The more you can get the thing organised on a unit basis the better. Everyone likes to see his name in print, and a boy especially. If Tom Jones gets his name in the paper, Bill Smith, green with envy, will join the Cadets.

As regards the housing side, the speaker has touched on a sore subject with all cadet units. Well, the charter is quite clear. We have told the Territorial Army that they have to look after at least one Cadet unit and we have told the Army Cadet Force that it is in their own interests to have a close affiliation with the local Territorial unit. In fact, I say that the success or otherwise of the Cadet unit will entirely depend on the relationship between the commanding officer and his Territorial counterpart. If they get on well together there should be very little difficulty about sharing the facilities in the various drill halls. If there is friction there will be no co-operation, so it is up to them. But it has definitely been given out that the cadets are to be given as much run of the accommodation as is practicable, and they must be encouraged to try to get some place of their own, particularly for their club and welfare side. There is no reason why they should not have the drill halls for the military side of their activities, but they cannot have all the rooms they have had before. I know that the arrangement is not ideal, but if the units try they may be able to help themselves to a certain extent.

Major A. LANSFORD: I am wondering whether the War Office could arrange for parties of Cadets to see the Royal Tournament at Olympia. There are probably many boys who have not seen a Royal Tournament.

Major-General URQUHART: I think perhaps Col. Kenyon will note that. It was mooted at the first Committee meeting of the Royal Tournament that Cadets (of all three Services) might be brought in to act as programme sellers, so that they could see the show and get publicity.

Lt.-Col. L. F. R. KENYON: Perhaps I might help with regard to the question of parents. I was talking to the company commander of a tough, but very good, collection of boys the other day and I asked him about discipline. He said "I have no trouble; I thrashed my company sergeant-major yesterday". I said "What about his parents?" He said "I go to the parents first and ask them whether they like the Cadet Force. They usually do and so I tell them I will either have to thrash their son or give him the sack. They prefer to have him thrashed". That is very much the view the parents take of it on the ethical side. On the material side, parents are realists, and with the recent issue of greatcoats they are strong supporters of the Army Cadet Force.

THE CHAIRMAN: I think the time has come for me to carry out the pleasant duty of proposing a vote of thanks to our lecturer. Before I do so I want to say a word about how glad I am to see such a good audience here and mention two classes of people I see here. The first is a number of people, some of whom have spoken in the discussion, who have a long record of experience and enthusiasm in the Army Cadet Force. We are delighted to see them here and, if I may single out one I should mention Lieut.-Col. Poole, who has forgotten more about the movement than most of us know. Again, I should like to give a hearty welcome to those representatives of foreign military forces whom we see here tonight. I hope they have thought the story worth listening to.

I should like to thank General Urquhart not only for the very clear way in which he has described the history and growth of the Army Cadet Force but also for the clear perspective in which he has put that story. The purpose of the Army Cadet Force, as you have seen, has really never varied and it will always remain steady if we keep in front of us the ideals of the original founders, namely, to put the good of the boy first and last. We have to adapt it to the changed conditions in which the Force has to work.

I hope this lecture will get much wider publicity even than it has in this room and we shall hope to publish it in due time in the *Cadet Review*.

You see plainly how the Army Cadet Force has really gone one full cycle of its ups and downs of popularity and how we are in the middle of the second cycle. You have heard of our popularity in the second world war, and now it is a question of whether the second cycle will follow the course of the first, or whether history is not going to repeat itself. If we have avoided that then it is because General Urquhart and his staff who were in office during the critical period have absorbed the lessons of the first cycle.

General Urquhart mentioned two or three things which I should like to emphasise. The first is that the Army Cadet Force, while it exists for the Cadets, does depend on its officers. The officers have the hard work. There will never be a shortage of Cadets if we have the right officers, and it is gratifying to see how officers are appearing now in the Army Cadet Force not only with the medals of Mons and Ypres but of El Alamein and D-Day. That is what we want, and the Force will not prosper unless we continue to get it.

Then there is this club and school problem. Personally I would say that an open unit cannot prosper and cannot be a balanced unit unless it develops its club life side-by-side with unit training. The club problem is the thorniest, as anyone will realize who has an acquaintance with the Education Act of 1944. There is no doubt, however, that if the matter is tackled on sound lines we shall succeed in reconciling the diverse claims of the school unit and the open unit, and in harmonising the whole into a healthy and useful Army Cadet Force.

Now what about the questions of publicity and of parents? I promised to say a word or two about those problems and I will take them together. I agree with the speaker who said that local publicity is important and is in the hands of the unit. After all, we may think this or that is news, but we are not the editors. It must be remembered that we have had articles about the Army Cadet Force in "Picture Post" and "Illustrated", but who is the best medium of publicity? The smart and clean and happy Cadet. There is no better advertisement for the Force than the good Cadet. He is the person to convince the parents. The parents, like other people, will judge by results. It is a difficulty I know well, particularly with the open units, and there is no royal road to overcoming that difficulty.

I will now ask you to join with me in giving General Urquhart a very hearty vote of thanks for his amazingly good lecture.

Major CADMAN, M.B.E.: This Society prides itself on the high quality of its lecturers, and I am sure you will agree that we could not have had a better lecturer than we have had tonight. Major-General Urquhart has covered the whole subject from A to Z. With regard to our Chairman, I know of no one who could have been more suitable to take the Chair for this Lecture than Major-General Lord Bridgeman, not only because of his long association with the Army Cadet Force but also because of his magnificent work in connection with the Territorial Army and the Home Guard. His continuous enthusiasm for the Army Cadet Force, and the important part he has played in its development from the beginning, fits him admirably for the important position he now holds.

I should like to mention that this lecture will be published in full, with the discussion, in the *Journal* of the Society. The Royal Society of Arts will be helping the Army Cadet Force by that publication because it will reach quite a different audience from that which receives the A.C.F. publication.

This lecture will convey to many for the first time a true picture of the Army Cadet Force. I am sure that there are many who do not know that it means a great deal more than simply pre-service training. When it is realized that there is also to be a very important social side included in all units, and that it is undoubtedly one of the best ways of training for future citizenship, the reading of this most informative lecture throughout the country will, we hope, bring in many new recruits.

We are greatly indebted to Lord Bridgeman for taking the Chair, and for his contribution to the discussion. I hope that when next we have a lecture on this subject, instead of the Chairman having to report that only 50 per cent. of the youth of this country belong to any youth organisation, he will be able to report a very much better position.

It is now my pleasure on behalf of the Council of the Society and on behalf of the meeting to propose a hearty vote of thanks to our Chairman.

The vote of thanks was carried with acclamation.

THE CHAIRMAN: Thank you very much indeed for your vote of thanks. Everyone who has to do with the Army Cadet Force will be glad to know that we have so staunch an ally as the Royal Society of Arts.

The meeting then terminated.

ECONOMIC RECONSTRUCTION (III)

MATERIALS

By F. A. FREETH, O.B.E., D.SC., PH.D., F.R.S.

Eleventh Ordinary Meeting, Wednesday, February 12th, 1947

Mr. W. LEONARD, M.P., *Parliamentary Secretary, Ministry of Supply*, in the Chair

THE CHAIRMAN: First of all I have to bring to you the apologies of my Minister, who regrets very much his inability to be with us this evening. The loss is his, I am sure, and the pleasure is mine.

The title of the paper this evening is a simple one so far as the word itself is concerned, but the paper contains matter of tremendous importance to everyone here and to industry in general. Not only the Ministry of Supply is especially interested in the utilisation of raw materials for the stores and equipment we must produce for H.M. Forces, but also every industry in this country to-day, because in looking towards the future they see with apprehension that the raw materials they used to utilise will have competitors in the market and that new materials are coming into the field.

We have in Dr. Freeth one who is eminently capable of giving us all the guidance we can require on this subject and we are highly honoured that this matter is to be handled by a gentleman such as he. He has had great experience with a famous company which used to be called Brunner, Mond & Company, and is now Imperial Chemical Industries, Ltd.

War has at all times opened great fields for inventors, and in the 1914–18 war Dr. Freeth was in very great measure responsible for work in connection with a series of reactions for explosives which was to the great advantage of those capable of applying the results of his research. He is now continuing his interests on the central staff of I.C.I. in the field to which I have referred, perhaps a more general one than in the past. Notwithstanding the developments so far as materials are concerned and the things we have seen in the popular Press and elsewhere, I am sure that this evening Dr. Freeth will give us something to think about regarding materials in the future.

Dr. FREETH then read the following paper:

When first I was invited to deliver a lecture on materials before your Society I thought that an interesting choice would be to talk on housing, as it is a subject that touches closely the lives of every one of us, and the materials which may and may not be used in housing cover a very wide range. Your Committee, however,

asked me not to restrict myself and to talk on any materials I liked, which makes my task both easier and more difficult.

Materials are inextricably mixed up with the way in which they are used, and frequently a very old material may, in a manner of speaking, become a new one; so tonight I am going to talk to you about some new materials and some very old ones.

You may have noticed from time to time that when you have heard of something particularly novel and interesting which has been discovered you sometimes never see it or hear of it again. This is not due to any fault of our energetic popular Press, but to a very real difficulty—the lag between discovery and its application to every-day life; and tonight, as well as talk about some interesting substances, I have ventured to comment on the lag between discovery and application, and to make a few suggestions on the overcoming of this difficulty.

I am going to begin with a dramatic material, dramatic because it was discovered at exactly the right time. Here it is. It is called polythene, and it looks and feels rather like a piece of candle. It differs, however, from a candle in being strong, as you will see when I snap this candle in two and attempt to do the same thing with a piece of polythene. This stuff is tough. It has all the electrical virtues of paraffin wax and is strong into the bargain. It can be easily moulded, is water-repellent, and transmits water vapour only exceedingly slowly.

What is it? It can well be called solid dehydrated alcohol. Alcohol, the common kind, ethyl alcohol, has the formula C_2H_6O. If you vaporise it and pass it over a particular chemical substance known as a catalyst, it breaks up into a gas called ethylene of the formula C_2H_4, and water, which is H_2O, and it is obvious that C_2H_4 plus H_2O have been derived from the original alcohol C_2H_6O. The water is removed from the gas by condensation. The gas is mixed with a carefully regulated minute quantity of oxygen and compressed to 1,200 atmospheres, that is, to about 18,000 lb. per sq. in. at a temperature of 200°C. The gas then condenses to the prosaic-looking solid you see in front of you, which has exactly the same chemical formula as the gas, but instead of the formula being simply C_2H_4 it is about C_2H_4 a thousandfold.

This material was discovered in the Research Department of Imperial Chemical Industries at Winnington in Cheshire. A full history of this discovery would take far more time than is at my disposal this evening, but it should be mentioned that we owe a great deal to the collaboration of Professor A. J. M. F. Michels, of the University of Amsterdam, who is an authority on scientific work at high pressures. We made his acquaintance a good many years ago, and came to the conclusion that if we did systematic chemical work at high pressures we might discover something valuable. Michels designed the pump with which we discovered polythene. We worked for over a year without getting any reasonable chemical results, but in the end we found it. The discovery is essentially one of inspired chemical prophecy sustained by good technique. The first pound or two of this material came out of the plant the very day when the Germans invaded Poland. What use is it? It has been called war-winning material No. 1. Without it ground and ship radar would have been very difficult and airborne radar impossible.

I lectured on this material to an international conference in Paris in September last, and Sir Robert Watson Watt was kind enough to give me a statement for that occasion, the relevant part of which I will now read to you:

"The introduction of radar for fixed ground stations in 1935 led to an immediate and insistent demand for the design of mobile stations for land use, of shipborne sets, and for the fitting of complete radar installations in combat aircraft. Difficult as were the ground and shipboard problems, they were easy compared with those of the airborne installations. High voltages are unpopular in the air, and an aircraft which must be parked in the open in all weathers, ready for instant action, is one of the least attractive platforms for equipment which on the one hand requires many kilovolts for its operation and on the other depends on a precise comparison of two very short-wave radio signals so weak as to be on the limit of perception at the moment when vital combat tactics have to be based on the comparison. Losses of energy had to be reduced to a minimum even when they were constant in value; variation due to moisture affecting differently the two sets of receiving aerials and the leads from them was fatal to directional accuracy.

The airborne set could work effectively only on wavelengths under two metres and best of all on wavelengths under ten centimetres. Orthodox dielectrics had intolerable losses or unacceptable mechanical limitations. The availability of polythene transformed the design, production, installation and maintenance problems of airborne radar from the almost insoluble to the comfortably manageable. Polythene combined four most desirable properties in a manner then unique. It had a high dielectric strength, it had a very low loss factor even at centimetric wavelengths, it could fairly be described as moisture-repellent and it could be moulded in such a way that it supported aerial rods directly on water-tight vibration-proof joints backed by a surface on which moisture film did not remain conductive. And it permitted the construction of flexible very-high-frequency cables very convenient in use. A whole range of aerial and feeder designs otherwise unattainable was made possible, a whole crop of intolerable air maintenance problems was removed.

And so polythene played an indispensable part in the long series of victories in the air, on the sea and on the land, which were made possible by radar. Polythene was an essential element in that 'single technical device' to which the Führer ascribed the 'temporary' (but it proved enduring) 'set-back' experienced by his U-boats. It made its contribution to the major naval combats typified by the action in which, as the Commander-in-Chief said, radar enabled the Home Fleet to 'find, fix, fight and finish the *Scharnhorst*'. It had its part in such continuing operations of the smaller naval craft as were delightfully summarised in one report: 'Our M.T.B.'s were enabled to detect the convoy, retire for a conference while they plotted enemy course and speed, deliver a deliberate and successful attack unobserved and retire unscathed with the enemy still in doubt as to what had hit him'.

It had its vital place in the small batch of sets of anti-U-boat airborne radar equipment which, with their shipborne counterparts—also polythene-aided—permitted the sinking of a hundred U-boats within a very few weeks. And centimetric aerial systems in polythene moulding multiplied the effectiveness of our bomber force by a very large factor indeed; the ruins of Hamburg and Berlin are a monument to a co-operation in which polythene played a great part.

It is most fitting that the story of how polythene came—a story to which the over-worked adjectives 'romantic' and 'dramatic' fairly apply, should have several chapters in common with the story—impressive, dramatic and perhaps not short of majestic—of that radar to which Admiral Dönitz has paid an unwilling but most handsome tribute."

Its peace-time uses are numerous and expanding. In ten years' time it may well be a heavy tonnage chemical.

Here is another substance totally different in use and effects. It is called "Methoxone" and it is used in agriculture. It has been said that one of the greatest benefactors of the human race would be one who could make two blades grow where one grew before. This stuff really does rather the opposite. Broadly speaking it destroys dicotyledons, that is to say, things which start off with two leaves, and

does not affect monocotyledons. That is to say, it will not affect grass, but will kill weeds. Wheat and other growing crops are monocotyledons, hence this stuff can be used for cleaning wheat fields of that pestilential weed charlock. The active material is intensely potent and its chemical formula is fairly simple. Its nature is akin to that of the growth-promoting substances in plants. The powder which you see in the bottle contains only a few parts of the active principle per thousand. It was discovered in Imperial Chemical Industries research laboratories by two chemists named Templeman and Sexton. A very interesting thing about this material is the problem of applying it and the way in which that problem was solved. Here is the difficulty. The neat material is rather of a buttery consistency. How are you going to spread ½ lb. of butter evenly over an acre? It is a far worse problem than our present butter ration! The difficulty was overcome by one of our chemists who, hearing of the requirements of the case, immediately thought of a way of solving it by using a manufacturing technique with which he was familiar.

Slaked lime is a beautiful impalpable white powder widely used in many trades, notably in building. It is made by taking quicklime and adding the right amount of water to it. Heat is generated. The water combines with the lime and the lumps of quicklime fall to a smooth white powder. Now, if to the water used in slaking there has been added a little of the "Methoxone" which kills the weeds, the reaction goes on as before, but the slaked lime now contains intimately mixed with it a small quantity of the weed-killing material. This slaked lime containing the "Methoxone" is further diluted with finely ground limestone dust and sent thus to the farmer in sacks. The dust is easily handled by existing agricultural machinery.

This brainwave enabled us, with practically no modification of existing plant, to produce thousands of tons of mixture to meet the demands of the Ministry of Agriculture. If special processes and machinery had been necessary this would have been totally impossible in point of time, and might well have been a failure in application.

We have dealt with two rather exciting chemicals. Now let us have something which the Lancashire comedian would call "proper humdrum". It is called soda ash. It is made from salt, and is one of the raw materials from which raw materials are made. It is quite unspectacular. It would be much easier to say what it does not do than what it does. For example, it is used in the manufacture of glass, soap, paper, textiles, metals, wool scouring, and as a starting point for many other chemicals.

One of the celebrated Victorian statesmen once said that the production of sulphuric acid was a measure of the industrial strength of a community. He could equally well have said soda ash. Sometimes it is only used in very small quantities, which are quite essential. That is to say, a material worth hundreds of pounds per ton may depend for its production at one stage on the use of a few pennyworth of soda ash.

Although it is an old material new uses for it are constantly being found, and these new uses nearly always come slowly, which is a testimonial to the slow way in which new techniques and researches travel.

I would now like to turn and say a few words about housing. In many ways the ground is moving under our feet. Take, for example, the methods of clearing a site and digging the foundations. All these have behind them the idea of getting more

result from the numbers of men employed, a most important matter in this time of scarcity of labour. We have metals replacing each other, sometimes according to their scarcity, sometimes by reason of the amount of man power required to manipulate them. Whole houses, as you all know, are now built of aluminium, the result not only of its excellent properties, but of the enormous strides which were made in its production for the aircraft industry during the war, the extent of which is perhaps not fully realised by everybody.

Then we come to plastics. Plastics have enjoyed a great deal of publicity and prophecy, rather more than they deserve, but nevertheless plastics have come to stay and are very important. You have two kinds. What does one mean by plastic? It is not easy to define strictly, but we have all got a very fair idea of what is meant. We mean some material which can be easily and rapidly moulded and will have a number of desirable properties. There is also the very important use of plastics for holding together wood. Laminated woods can be used for all sorts of jobs where it is hardly practicable to use ordinary woods. Plastics are of two kinds, those which are when heated and moulded stay so for good and cannot be further influenced by heat, and those kinds of plastic which when moulded can be softened again by heat and sometimes used again. You can use plastics for moulding, fabrication, adhesives, flooring, roofing, heat insulation, plumbing, etc. I have on the table in front of me a few interesting applications of plastics, one of which you will all know in the form of the glass-like material which is used for the windows of aeroplanes.

In metals we have an immense variety at our disposal. There is, for example, a new cast iron normally twice as strong as the cast iron which we know, which has recently been discovered by the British Cast Iron Research Association. As far as I am aware its composition has not been announced, but only its properties. Its effect, both in saving material and fuel, is bound to be very marked in the future, if only the discovery is rapidly developed, and that remark brings me to what you might call the sermon part of my lecture, namely, the difficulty of exaggerating the importance of technique, and the fact that for practical purposes new techniques might be said only to travel by word of mouth and by seeing them. This statement applies to pretty well everybody, scientists included. There has been so much talk about scientists in the last ten years that if you did not know you might think we were less fallible than anybody else; as a matter of fact we are just as fallible as the next man, as they say in America.

Methods of doing things in science are very often carried on by pupils of a famous man who leave him and diffuse the new knowledge and method wherever they go, but it is the personal contact and the seeing with one's own eyes which are so very important. Take a prosaic matter like knitting. Why does a woman in England knit differently from the women all over the Continent? You have only got to watch a German woman knitting and an English woman knitting and you will see how they differ in their way of going about it. Which is the better? Has anybody ever tried?

It is all very well for me to criticise the slow way in which technique and development takes place unless I can make some sort of constructive suggestion for doing something about it, and the answer is, far more travel at every level. Scientific men travel to a certain, but not nearly sufficient, extent. Business men travel, but not

enough, and technicians of all grades do not travel anything like as much as they ought to. The only way to learn how to do anything in practice is to see it done and have a go at it yourself. That this is so you can easily see if you remember the exasperation which is produced in you when you try to set up a complicated machine or piece of apparatus, or even a puzzle or a child's toy from a set of instructions. An immediate sense of frustration is produced.

I am therefore suggesting that not only should scientists, works managers, laboratory assistants and so forth see what is done in similar trades to their own in other countries, but that selected workmen should also visit their opposite numbers in other countries and work alongside them and come back with the knowledge and experience they have gained. That is why I said at the beginning that it is all very well talking about new and exciting materials unless you took the whole picture into account, namely the way in which they are also used; and the man who is handling them can sometimes teach us all a very great deal.

Shortly after I was invited to give this lecture and had made up my mind the course which I should follow, I ran across a case of a new development in this country which will illustrate what I meant about the way in which technique travels. As it is useful in housing, the pressure of circumstances may hasten its application, but at present it is not in large-scale production. It is a material known as Vermiculite, a complex hydrated aluminium and magnesium silicate. This material when heated at the proper temperature swells up like the frog in the fable and becomes a most excellent non-conductor of heat. It is used on a very large scale in America and has a wide application for building construction in industry. In the U.S.A. it has been used as an insulating material for housing, and in one case in an ordnance plant with an area of 2,000,000 sq. ft. I do not propose to go into any great detail in this matter, but the interesting part about it is that at this moment it is in the pilot stage, that is to say, there is a small low-capacity plant being used for the production of trial samples. How long will it be before this material is produced on a very large scale? Its record in the United States seems to justify a great push with it here. I have got some samples on the table in front of me.

Consider for a moment another extraordinary mineral of the most diverse uses—asbestos. Asbestos is found in very many countries, but unfortunately not in ours. The variety of its uses is extraordinary—yarn, felt, paper, millboard, insulating wire, cloth, clutch facings, gaskets. In a recent pamphlet on asbestos the uses run to four pages, merely giving the items, including ten in the moving picture industry.

Finally, you will see in front of you a new and very interesting material which, if you like, you can call "wool from peanuts". The peanuts will be brought over here from Africa, the essential oils extracted and some of the residue used for making the cloth which you see in front of you. This material was developed by Imperial Chemical Industries in Scotland and is known as Ardil. It mixes very well with wool and when, as I hope some of you will do, you feel it and handle it at the end of the lecture, you will see that it is a very pleasant material and stands up to the most severe criticism, namely that of the housewife and the Yorkshire woollen manufacturer.

The question naturally arises in dealing with materials, especially with new ones, how do they fit in with the general economic framework of the country? A synthetic

material may be something which was never prepared before and has manifest good points and uses, such as this piece of Perspex which I have in my hand. It is very largely made in the first case from coal, which used to be our greatest friend and the lack of which is now by far our greatest enemy. Many synthetic materials require coal for their production, and coal in pretty large quantities. On the other hand, coal very often is used only as a source of energy. It is a pity that the use of energy from the breakdown of the so-called atom did not come a generation sooner and on an industrial basis. For the next generation, until we get atomic energy well into harness, we are by and large going to rely on coal, especially in Great Britain. This gap between the use of coal, which after all made industrial England, and the atomic age in the future is not going to be an easy one to bridge.

As I said before, the way in which to get new materials employed is to let people of every level see where they are used at present: if the employment is completely new, to acquaint as many people with it as possible. It is difficult to exaggerate the importance of the emotional background of all these material things. Given enthusiasm and the will of people in general, there is nothing to stop us going from strength to strength.

Finally, as a kind of apology for talking in this strain, I would like to quote to you the magnificent words of Francis Bacon which occur at the end of the first book of the *Advancement of Learning;* "Nevertheless I do not pretend, and I know it will be impossible for me by any pleading of mine, to reverse the judgment, either of Aesop's cock, that preferred the barleycorn before the gem; or of Midas, that, being chosen judge between Apollo president of the Muses and Pan god of the flocks, judged for plenty; or of Paris, that judged for beauty and love against wisdom and power; or of Agrippina, let him kill his mother provided that he become emperor, that preferred empire with condition never so detestable; or of Ulysses, who preferred an old woman to immortality, being a figure of those which prefer custom and habit before all excellency; or of a number of the like popular judgments. For these things continue as they have been: but so will that also continue whereupon learning hath ever relied, and which faileth not: wisdom is justified of all her children".

DISCUSSION

The lecturer replied to questions from members of the audience as follows:

Q. Is the expanded vermiculite available in this country? I have seen samples made into wall boards, but there seems to be no source of supply.

A. The answer to that is Yes and No. It is commercially available for people who want to pioneer with it. I will tell the speaker where he can obtain it if he will speak to me at the end of the meeting.

Q. Is it a fact that sodium carbonate is in short supply and that that accounts for the shortage of glass?

A. I do not know the facts, but sodium carbonate is essential for the manufacture of glass, and coal is essential for the manufacture of sodium carbonate. It would be disastrous to let the supply of sodium carbonate go down too much.

Q The question I should like to ask is very simple, although it may perhaps be an unfair one. We have heard a lot about the lag between invention and application being due to the fact that people will not go and see things. We know that Dr. Freeth is the representative of a very great combine and we have heard in the past that very often things which are of great merit may not be made available to the public because their

production might interfere with some other branch of activity of a combine of that magnitude.

A. Well, you know, I am not an experienced public speaker, but I get about a good deal and I am often asked about things like that. With my hand on my heart I say that I do not know of any combine that has stopped or prevented the manufacture of anything. Can you give me an example? The allegation is that someone brings out a patent and someone else buys it up. Well, you could not do it in the chemical industry. It would be impossible.

Q. Was there not some talk of a match which could be re-ignited several times?

A. Oh, that famous match! If you remember, some time during the last six months it was hung out to dry for the excellent myth which it is.

Q. I was ver interested in the new material, Ardil, but I am not sure whether the lecturer told us what advantages it had over wool. I have in mind that there are colossal quantities of wool in the world and it looks as though it may be a problem to know what to do with it.

A. I think you will find that the world is a big place now and very large numbers of people are asking for things they have never asked for before. Any wool grower who is frightened that his market will fail is alarming himself unduly. The price of Ardil is about half that of wool.

THE CHAIRMAN: I seem to have heard that from 14 lb. of peanuts you can get 5 lb. of margarine and close on a bottle of gin!

Dr. FREETH: I cannot answer that one, but it sounds highly satisfactory!

Q. Is Ardil commercially workable?

A. There is a fair-sized plant working now, but Ardil is not on the market yet. It is all very well to talk about these things but the problem is to get them going. When you come to manufacture for the market you must manufacture steadily. Ardil is undergoing large-scale trials at present.

Q. I am wondering whether there are any by-products from wool which would affect the conditions of the wool supply.

A. Wool is a great industry and a small newcomer like Ardil will not affect it under a generation, perhaps two. If I were a wool grower I would not worry about it for five minutes.

Q. There is a point arising out of the discussion which I should like to put. We have seen that many of the raw material resources of the world are showing signs of drying up. There is a tendency for materials to be developed, such as Ardil, the production of which uses the available raw material. There is the old bogey of synthetic rubber. It can be made as good as natural rubber, but it would be using up very valuable raw material, whereas we can grow rubber. Is there a spirit in industry which recognises that, and would it say "No, we will not make this material; it is an excellent material but it is using raw materials which could be used in another direction"?

A. I cannot speak for the whole of industry, but as regards my own industry I am quite certain that they would not do that.

Q. I think the most interesting point made is that about seeing for oneself. Of course, one of the limiting factors in this is whether manufacturers are going to be willing to let you see for yourself. For instance, would the I.C.I. allow a member of another perhaps competitive firm to go round its development department and have a look at their equipment? Another point is this. I have actually contacted I.C.I. on occasions about new materials and have ordered small trial quantities and one always has a fear that about a week afterwards a representative is going to come round and say "Just what are you going to use this for?", and want to know the reasons and so on. You rather feel that if you are poaching on their preserves your raw materials will tend to dry up.

A. I am afraid the speaker has got this combine bogey in mind. We have quite a large number of people we call our technical service, who are very anxious to help our customers. If one of us wants to know what you are using a certain material for, it is

because he wants to help you with it. By and large we make materials and other people make things from them. We are anxious to help people make things with our materials. That is the explanation, I am sure.

Q. During the war I was taken round an I.C.I. factory and there I was shown an explosive which was very powerful and very, very slow. It was possible to make it cartridge shaped and it was said that it was quite possible to use it in a motor-car.

A. Yes, you can start your motor with a cartridge. A lot of work of that sort is going on.

Major W. H. CADMAN, M.B.E. : It would be interesting to the Royal Society of Arts to know Dr. Freeth's views on the possibility of some of these new materials—particularly those which might be suitable for building purposes—being available by 1951.

Dr. FREETH: In four years? The trouble about that question is that it is necessary to make contingent replies. If we can get industry nicely on its feet again we can probably make a very good attempt at an Exhibition in 1951.

THE CHAIRMAN: Might I ask another question? With regard to the powder for agriculture, have the test trials been long enough to see whether the powder is deleterious in its effect on the land?

Dr. FREETH: I should say that as it is of the order of half a pound an acre and is organic in nature the possibilities of a deleterious effect are very small. You could get things like molybdenum persisting, but the fact that this material is of a benzenoid nature means, I think, that the bacteria in the soil will make a good meal of it quickly.

A MEMBER OF THE AUDIENCE: I should like to make reference to two materials which I have recently come across and which have not been mentioned this evening. One is glass in the form of woven material which is now processed to very interesting patterns. It can be done on Jacquard looms to produce an embossed pattern, and there is a glass silk which is used as an insulator. One trouble is that we are trying to adapt an American process and it is not so successful here.

The other material is one which has been developed in the London area, and it is extremely light in weight. Its density is 15 oz. per cu. ft. and that is an interesting development which has an application both in the building trade and in aircraft, because in many ways we pay for materials by weight and so a saving in weight is of advantage. That material is made from craft paper and is used for internal panelling and ceilings.

THE CHAIRMAN: I think we are very much indebted to Dr. Freeth, and it is my duty to ask this audience to accord him a very hearty vote of thanks for his lecture and the manner in which he has answered questions.

Major CADMAN: May I on behalf of the Council of the Royal Society of Arts and on your behalf propose a hearty vote of thanks to Mr. Leonard, who is Joint Parliamentary Secretary, Ministry of Supply, for presiding this afternoon. He has made a useful contribution to the discussion, and has been an admirable Chairman. I hope that he will convey to the Minister of Supply, for whom he is acting as deputy to-day, the suggestion put forth by Dr. Freeth about the desirability of selected representatives of industries travelling abroad to see for themselves what is being done in other countries. Might I add a suggestion of my own? It may not be generally known that Dr. Freeth, who has done such brilliant chemical work, has been a free-lance research chemist for Imperial Chemical Industries, thanks to the far-sighted policy of the directors. I suggest that in the Ministry of Supply, and also in other Ministries, it would be an excellent plan to copy this system of allowing a few picked research workers and specialists to be turned loose as free-lance investigators. They should not be bound by red tape or restrictions of any kind, but should be left free to travel anywhere they like to develop new ideas and work them out for themselves wherever they found to be most convenient. The ultimate results of such freedom of action would be of inestimable value to this country. Some of the valuable materials mentioned by Dr. Freeth have been discovered and others developed in this way.

The vote of thanks was carried with acclamation, and the meeting then terminated.

GENERAL NOTE

THE COUNCIL FOR VISUAL EDUCATION.—The Council for Visual Education was formed in 1942, with the object of encouraging the teaching of the appreciation of good design in schools. It was the belief of the founders that only the teaching of such appreciation, as a background subject and a connecting link between other studies, could overcome the lack of design and beauty which is evident on all sides. The Council set about their task by the production of booklets, of which the first are *The Future Citizen and his Surroundings*, *Architecture as a Communal Art*, *Art and Everyman* and *Visual Pleasures from Everyday Things;* by the production of exhibition displays; and by assistance in organising lectures. The demand for the booklets, supplied at 6*d.* for the set of four mentioned, and for the first two exhibitions, on Housing and Domestic Architecture, has been considerable.

It will be apparent to Fellows of the Royal Society of Arts that the aims of the Council for Visual Education are such as to engage their sympathy and appreciation, being in a measure complementary to the Society's policy for the improvement of industrial design. It is pleasant to learn that many educationists are interested in the project, and that the Council receives numerous requests for information and expressions of support from teachers.

The Council will hold its Fourth Annual General Meeting on May 6th at 1.15 p.m. at the Society's house, and will welcome any Fellows who are interested at the meeting. Sir Patrick Abercrombie will preside, and Sir Kenneth Clark, K.C.B., Slade Professor of Fine Art at Oxford University and formerly Director of the National Gallery, will speak on the need for the appreciation of design. A discussion will follow.

A buffet lunch will be served at 12.45, price 2*s.*, payable at the meeting. Those desiring lunch should inform the Hon. Secretary, 13 Suffolk Street, S.W.1, not later than May 1st.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, APRIL 14..Engineers, Society of, at the Geological Society, W.1. 5 p.m. J. C. Milton, **"Research and New Developments in Water Treatment."**

Farmers' Club, at the Royal Empire Society, W.C.2. 2.30 p.m. H. H. Nicholson, **"The Problem of Land Drainage."**

Geographical Society, Royal, S.W.7. 5.30 p.m. A. M. Champion, **"Kenya Tribes."**

TUESDAY, APRIL 15..Electrical Engineers, Institution of Savoy Place, W.C.2. 5.30 p.m. J. W. Dalgleish, **"Does Standardization Conflict with Progress."**

Eugenics Society, at the Royal Society, W.1. 5.30 p.m. Dr. Linford Rees, **"The Physical Constitution in Mental Illness."**

Illuminating Engineering Society, at the School of Hygiene and Tropical Medicine, W.C.1. 6 p.m. **"Problems Associated with Searchlights (Visibility of Targets, Photometry, Design, etc.)."**

Industrial Transport Association, at the Royal Society of Arts, W.C.2. 6.30 p.m. Annual General Meeting.

Mining and Metallurgy, Institution of, at the Royal Institution, W.1. 5 p.m. Major-General A. J. Orenstein, **"The History and Prevention of Silicosis with Special Reference to the Witwatersrand."**

WEDNESDAY, APRIL 16..East India Association, at the Royal Society, W.1. 2.30 p.m. Lady Pares, Mrs. Lankester and Miss Dorothea Lankester, **"The Women of India To-day."**

At the Royal Victoria Station Hotel, **Sheffield** 6.15 p.m. K. A. Sumner, **"The Heat Pump."**

Meteorological Society, Royal, 49 Cromwell Road, S.W.7. 5 p.m. E. Gold, **"Weather Forecasts."**

Mining Engineers, Institution of, and Mining and Metallurgy, Institution of, at The Royal Institution W.1. 10.30 a.m. (also on April 17th) **Conference on Silicosis, Pneumokoniosis, and Dust Suppression in Mines.**

THURSDAY, APRIL 17..Aeronautical Society, Royal, at the Institution of Civil Engineers, W.1. 6 p.m. P. A. Hufton, **"Testing Civil Aircraft."**

Chemistry, Royal Institute of, at the Engineers' Club, **Manchester.** 7 p.m. A. H. Baines, **"Recent Work in Colour Photography."**

FRIDAY, APRIL 18..Physics, Institute of, at the New Physics Theatre, **Manchester University.** 7 p.m. D. O. Sproule, **"Material Testing by Supersonics."**

TUESDAY, APRIL 22..Physics, Institute of, at the Royal Society, W.1. 5.30 p.m. S. Rodda, **"Electron Multipliers."**

WEDNESDAY, APRIL 23..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. D. Gabor, **"New Possibilities in Speech Transmission."**

THURSDAY, APRIL 24..Aeronautical Society, Royal, at the Institution of Civil Engineers, W.1. 6 p.m. Dr. J. W. Drinkwater and W. G. Glendening, **"The Risk of Fire and Fire Prevention Methods."**

Electrical Engineers, Institution of, at Kingsway Hall W.C.2. 5.30 p.m. Professor L. B. Loeb, **"Electrical Discharge through Gases."**

FRIDAY, APRIL 25. Chemical Industry, Society of, at the Engineers' Club, **Manchester.** 6.30 p.m. Dr. C. M. Dyson, **"A New Notation for Organic Chemistry."**

Sanitary Institute, Royal, in the Town Hall, **Carlisle** 10.30 a.m. F. H. Day, **"Dust in Domestic and Public Buildings: Its Nature and Properties."**

Sound Recording Association, British, at the Royal Society of Arts, W.C.2. 7 p.m. A. H. Watts, **"Modern Direct Disc Recording."**

Statistical Society, Manchester, at 16 St. Mary's Parsonage, **Manchester** 6.30 p.m. E. D. van Rest, **"Probability and the Engineer."**

SATURDAY, APRIL 26..Geographical Society, S.W.7. 2.30 p.m. Miss M. Simpson, H. Bruce Woolfe, and G. J. Cons, **"Visual Aids in Geographical Teaching."**

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IT was in the North of Essex that Courtaulds' business was founded. In 1816 at Panfield Lane, Bocking, Samuel Courtauld set up his first premises midway between the great silk centres of Norwich and London. Nine years later his two brothers joined him in partnership as silk throwsters, and soon they were making crape on an extensive scale with factories at Bocking, Braintree and Halstead.

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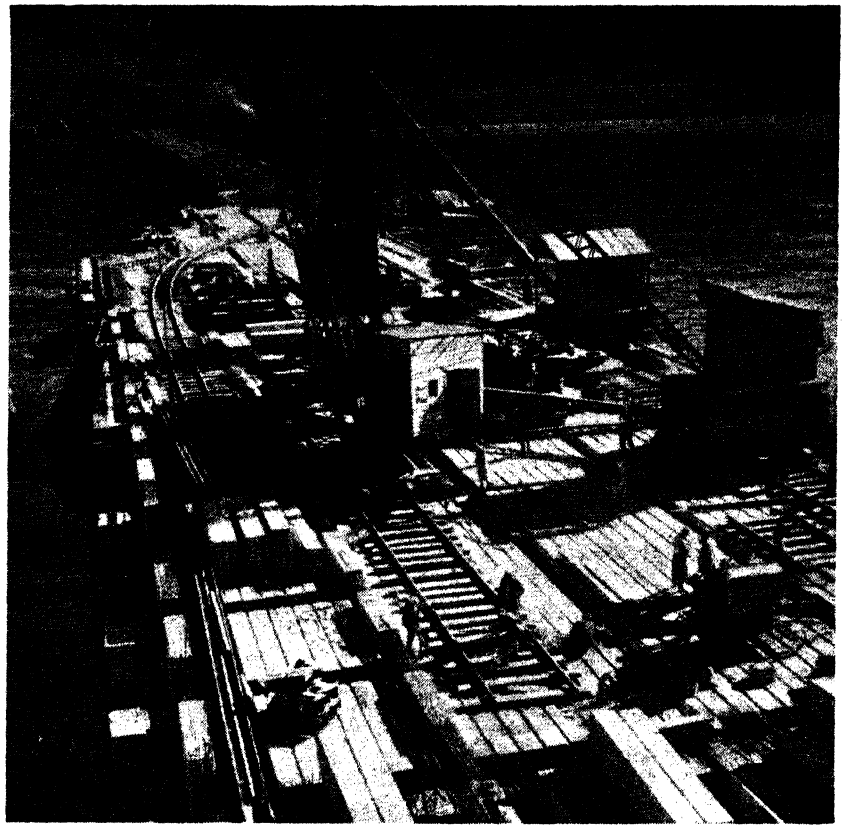
Today at Braintree mill, rayon is processed, woven and knitted; there, the new British knitting machine, fastest in the world, has recently proved itself. At Bocking, fabrics are dyed and finished, and furnishing and other fabrics are woven at Halstead.

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4741 *FRIDAY, APRIL 25th*, 1947 Vol. xcv

MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

Ordinary Meetings

Wednesday, April 30th, at 5 p.m.—"Economic Reconstruction"— (vii) "Distribution". By E. J. B. Lloyd, B.A., LL.B., Director and Secretary, Lewis's Investment Trust, Ltd. The Right Hon. Lord Woolton, F.C., C.H., D.L., LL.D., in the Chair.

Wednesday, May 7th, at 5 p.m.—"Gas in the Home". By Mrs. G. E. Abbott, Organising Secretary, Women's Gas Council. Sir Charles Tennyson, C.M.G., Chairman of the Central Institute of Art and Design, in the Chair.

Cantor Lecture

Monday, May 5th, at 5 p.m.—(First of three.) "Recent Developments in the Application of Photography". By D. A. Spencer, PH.D., D.I.C., HON.F.R.P.S.

Syllabus for the Course

Lecture I.—Air Photography.

Interpretation of air photographs, application to survey, archæology, ecology, forestry, geology, prospecting and land utilisation.

Lecture II.—(May 12th, at 5 p.m.) Industrial Photography.

Industrial applications, with particular emphasis on war-time developments in record making, control of quality of raw materials, photo-templates, radiography, high-speed photography and cinematography.

Lecture III.—(May 19th, at 5 p.m.). Photography in Education.

Photography as a teaching and training aid. Motion study. Visual aids. Sub-standard films, film strips and film slides.

MEETING OF COUNCIL

A meeting of the Council was held on Monday, April 14th, at 2.30 p.m. Present: Lord Bennett (in the Chair); Mr. F. H. Andrews; Sir Frank Brown; Major W. H. Cadman; Sir Edward Crowe; Mr. E. W. Goodale; Professor C. S. Gibson; Miss Caroline Haslett; Dr. R. W. Holland; Sir Harry Lindsay; Sir Henry McMahon; Mr. G. K. Menzies; Mr. J. A. Milne; Sir Ernest Pooley; Mr. J. W. Ramsbottom; Mr. E. M. Rich; Mr. E. Munro Runtz; Lord Samuel; Mr. William Will; Mr. J. G. Wilson; and Miss Anna Zinkeisen; with Mr. K. W. Luckhurst (Secretary), and Mr. C. Burns (Assistant Secretary).

The following were duly elected Fellows of the Society:

Agate, James Evershed, London.
Ashby, Maurice, PH.D., Tiverton, Devon.
Ashdowne, Herbert Arthur, B.SC., Edinburgh.
Bank-Anthony, St. Michael Mobolaji, London.
Barnson, James Dudley, M.A., Edinburgh.
Bentley, Clive Allan, London.
Billington, Neville Samuel, M.SC., Uxbridge, Middlesex.
Brebner, John Hector, London.
Chalkley, Alfred Philip, London.
Chalmers, Rear-Admiral William Scott, C.B.E., D.S.C., Titchfield, Hants.
Champion, Professor Harry George, C.I.E., M.A., Oxford.
Champion, Sir Reginald Stuart, K.C.M.G., O.B.E., Aden.
Cochran, Charles Blake, London.
Collins, James Daniel, M.A., B.L., LL.B., Dundee.
Coutts-Duffus, James, Dundee, Angus.
Dodsworth, Geoffrey, London.
Drimmie, George Keith, J.P., M.A., Keith, Banffshire.
Eccles, John Frederick, O.B.E., Welwyn Garden City, Herts.
Eisel, Major Henry William Christian, M.A., M.LITT., Bickley, Kent.
Entwisle, The Reverend Hubert, D.D., Sunderland, Co. Durham.
Evans, Professor Meredith Gwynne, D.SC., Leeds.
Ewins, Arthur James, D.SC., F.R.S., Leigh-on-Sea, Essex.
Fisher, Stanley William, Bewdley, Worcestershire.
Francis, Marcus, B.SC., Stoke-on-Trent, Staffs.
Gardner-McLean, Colonel George Hunter, O.B.E., Glasgow.
Goodall, Sir Stanley Vernon, K.C.B., O.B.E., London.
Green, Arnold Trevor, O.B.E., Stoke-on-Trent, Staffs.
Gregory, Henry Alexis Chodak, M.C., M.B., CH.B., Huntingdon, Hunts.
Hey, Professor Donald Holroyde, D.SC., PH.D., London.
Hirst, Major Eric David Wear Brown, M.A., R.E., Trinidad, B.W.I.
Hiscock, Walter George, B.SC., PH.D., Bristol.
Hodge, Leslie Richard, Enfield, Middlesex.
Hughes, Leslie Ernest Charles, B.SC., PH.D., London.
Jones, Alderman Joseph, C.B.E., LL.D., J.P., Barnsley, Yorks.
Jones, John William, Derby.
Jones, Sir Walter Benton, Bart., Grantham, Lincs.
Jupp, Percy William, C.B.E., London.
Keay, William, Leicester.
Kihn, William Langdon, Connecticut, U.S.A.
Kilmarnock, The Rt. Hon. Lord, M.B.E., London.
Lisle-Cocking, Ernest, D.SC., Melbourne, Australia.
Lockyer, Miss Mildred, A.R.C.A., Leicester.
Maskell, Leslie, Caterham, Surrey.
Miller, John Leonard, D.ENG., PH.D., Billinge, Lancashire.
Milligan, Miss Frances Jane Grierson, Hereford.
Milne-Watson, Michael, London.
Minns, Arthur James, Ruislip, Middlesex.
Mitchell, Sir Kenneth Grant, K.C.I.E., Wickhambrook, Suffolk.
Moon, A. F. William, St. Albans, Herts.
Munro, John Jamieson, O.B.E., Stirling.
Musgrave, George Edward Stanley, Guiseley, Nr. Leeds.
Norton, Commander Gordon, R.N.V.R.(RET.), Warlingham, Surrey.
Parker, Harold Wilson, A.R.C.A., London.
Paul, Robert Hoisington, M.A., B.SC., Kollupitiya, Ceylon.
Pratt, Herbert William, Westcliff-on-Sea, Essex.

Ratcliffe, Henry Barwick, A.R.C.A., Huddersfield, Yorkshire.
Rogers, Bernard, Bristol.
Sandford, Jack, Southend-on-Sea, Essex.
Smith, John Leslie, O.B.E., B.Sc., Rochester, Kent.
Smoothey, Ronald William, Luton, Beds.
Snell, Derek, Lincoln.
Spears, Stewart Scott, O.B.E., London.
Stevens, Charles James Henry, Bexley, Kent.
Stewart, William, M.A., Aberdeen.
Subramanian, T. K., B.A., Tanjore District, S. India.
Tarr, John Charles, London.
Thomas, Sir Henry, D.LITT., D.LIT., London.
Thomson, William Wishart, M.A., Anstruther, Fife.
Urwin, Kenneth, M.A., D.LITT., Cardiff.
Vevers, Henry Gwynne, M.B.E., M.A., Plymouth, Devon.
Vitenberg, Miss Janine, London.
Wallis, Thomas, London.
Watson, James Douglas, London.
Wilkinson, Richard Leslie, B.A., Rawdon, Nr. Leeds.
Wilson, John, B.Sc., Cupar, Fife.
Wright, Stanley Little, Newton Abbot, Devon.

The following were duly elected Associate Members of the Society:

Dickson, Miss Mary Eileen Annals, Newark, Notts.
Walker, Geoffrey Fleetwood, London.

It was reported that, in view of the Parliamentary statement made by Sir Stafford Cripps on March 28th, the arrangement for an interview with the Parliamentary Secretary, Department of Overseas Trade, to discuss the proposed 1951 Exhibition, had been cancelled. The Council considered the terms of Sir Stafford's statement and decided to refer the matter back to the special Committee.

Further consideration was given to the award of the Society's Albert Medal for 1947.

Preparations for the Balloting List were begun by declaring vacancies.

Mr. A. C. Bossom, M.P., was re-appointed representative of the Society on the R.I.B.A. Board of Architectural Education.

Miss Anna Zinkeisen, R.D.I., was appointed representative of the Society on the Selection Committee for a crest for the National Coal Board.

Mr. Milner Gray, R.D.I., was appointed the Society's representative on the Central Organising Committee of the United Nations Poster Competition.

A design by Mr. Percy Delf Smith, R.D.I., for a book-plate, to be inserted in books awarded in lieu of medals to winners of the Society's Silver Medal for Papers and Lectures, was approved.

It was reported that 22,629 entries had been received for the Whitsuntide Examinations.

A quantity of formal and financial business was transacted.

APPOINTMENT OF MASTER OF THE FACULTY OF R.D.I.

Mr. Gordon Russell, C.B.E., R.D.I., has been elected Master of the Faculty of R.D.I. for 1947–48, in succession to Mr. Keith Murray, F.R.I.B.A., R.D.I. Mr. Gordon Russell's election will date from the Annual General Meeting of the Society.

ECONOMIC RECONSTRUCTION

(IV) FINANCE AND THE USE OF MONEY

By A. H. ENSOR
Chief General Manager, Lloyds Bank, Limited

Thirteenth Ordinary Meeting, Wednesday, February 26th, 1947
The Right Hon. LORD KENNET, P.C., G.B.E., D.S.O., D.S.C., *in the Chair*

THE CHAIRMAN: Let me introduce to this crowded audience, if any introduction indeed be necessary, our Lecturer tonight, who is Mr. A. H. Ensor, the Chief General Manager of Lloyds Bank Limited, on the subject of Economic Reconstruction from the aspects of Finance and the Use of Money. Mr. Ensor's intimate acquaintance, in his position, with the practical aspects, is no doubt what has made us particularly interested to hear him on this occasion, and to look forward to the paper which he will now read.

Mr. ENSOR then read the following paper:

In the opening lecture of this series, Sir Charles Lidbury described what he meant by Reconstruction, and the following words are an extract from his statement:

> "Firstly, restoration of our standard of living to something like a decent level. Secondly, to build up for the future a general state of sound, well-balanced economic activity, not only in Great Britain but in the world at large".

I have no reason to differ from those broad principles which Sir Charles outlined.

Economic Reconstruction related to Finance and the Use of Money is not a purely domestic matter, and the possibility of its successful and speedy achievement, both materially and financially, must be affected by world conditions, for a modernised and re-equipped industrial Britain—while it is the goal of our aspirations—could not be an accomplished fact if the rest of the world, particularly the United States of America, were in a state of depression.

In considering so wide a subject, one could examine the international aspects, survey the position of our own national finances, and consider the finance available for the requirements of trade and industry. To accomplish all these tasks in the time at my disposal would be impossible, and I propose, therefore, in the first place, to glance at what happened to our Industry during the war period, the manner in which the great industrial output was financed and its effects upon the problems of financing reconstruction.

Secondly, I feel that we ought to scan the position in America, as that great country is the keystone of world reconstruction and prosperity, and consider what contribution, if any, may be available out of our Dollar Loan towards our industrial reconstruction.

Then, finally, we might examine in more detail the part which finance can play, and consider whether it is possible to meet all the demands for assistance which may arise.

THE EFFECT OF TOTAL WAR ON INDUSTRY

Although, no doubt, you have heard it stated many times, I feel I must reiterate that total war such as we have experienced completely unbalances the financial and economic structure of a country so highly industrialised as Britain.

What, in fact, did happen? I think that a brief survey of the position would be helpful.

With regard to finance, credit or money, whichever term you prefer, this was almost entirely directed to the support of the national effort, and the issue of new capital, or the borrowing of money from banks, was specifically restricted to that purpose. The general control was placed in the hands of the Capital Issues Committee and the banks were requested by the authorities to co-operate on the lines of the general directions given to that Committee, a request with which they complied wholeheartedly. Exchange control also was instituted, which prevented any export of capital; we can, therefore, truly say that in our country we have had, and in fact still have, virtually a "closed economy". However much we may dislike financial controls, there can be no legitimate argument against their preservation in the immediate post-war period.

Turning to industry, practically every type which was not considered essential for war production or necessities ceased to operate, and our export trade dwindled perforce to small proportions. Through the guidance of the respective Ministries, who frequently provided the requisite machinery, factories commenced to turn out those innumerable products required for war purposes. One saw carpet manufacturers remove all their machinery and instal new plant in order to produce small arms ammunition. The motor industry gave their attention to armoured cars, tanks and aeroplane engines. Makers of woolly toys produced cannon shells, manufacturers of church furnishings turned out machine fuses, and makers of penny-in-the-slot machines produced loading devices for small arms and anti-aircraft guns. One could give many more examples, but perhaps these are sufficient to show the almost complete cessation of industry's normal functions. In fact, it would be true to say that the large majority of our manufacturers changed their production, and often their production methods, to meet the new and essential demands. This disruption of industry had a material effect upon the balance sheets of the companies, for, in very many cases, the Government became the principal, and often the only, customer—the items "Debtors" and "Work in Progress" becoming gilt-edged.

The financing of all these operations was carried out largely by the banks granting liberal credit facilities, and by progress payments made by Government Departments as and when certain stages of the contracts were reached. The banks were enabled to make very generous advances to industry, far in excess of what might be termed normal banking accommodation, realising that the important assets of "Debtors" and "Work in Progress" (protected by a break clause in the contracts) were the responsibility of the Government. If the management, organisation and costing were efficient, profitable business accrued to all the companies so engaged.

What sums they were able to retain in the business were, of course, dependent upon the incidence of taxation, which did not fall with equal weight on all companies. For instance, as you probably know, the companies with a successful history were not unduly affected by the incidence of the excess profits tax. Those which were fortunate enough to have experienced a particularly profitable year in one of the standard years were able to escape the payment of this tax. Companies which had an unfortunate standard, however, were unable to retain very much of

the additional profits earned, but as a contribution towards the rehabilitation of their business they can look to a refund of 20 per cent., less tax, of a proportion of the excess profits tax paid.

Looking through innumerable company balance sheets since the cessation of hostilities, one can feel assured that industry has never been so liquid as it was when war production ceased—cash at bank and British Government securities being quite common items. To some extent, therefore, industry can provide something from its own resources, certainly for rehabilitation, if not for comprehensive reconstruction.

The American Position

Let us now look briefly at the American position. Although you may feel that it is irrelevant, I think we ought to appreciate the extent to which the position in America can affect our own Economic Reconstruction. The negotiations, discussions and newspaper articles relating to the American loan to Britain will be fresh in your minds, and whilst many of us hoped that a goodly portion of that sum would be available for the purchase of raw materials and new specialised machinery for our factories, in order to speed reconstruction, we have been faced with many disappointments. One example may suffice—steel, of which there is a serious shortage. It was anticipated that during the year 1947 we should have been able to buy 2,000,000 tons from the U.S.A., but it now transpires that there is little hope of obtaining any supplies from that quarter. I do not suggest that we should anticipate importing steel from America in normal times—we could not afford to do so—but as an expedient to assist rapid rehabilitation it would have been helpful.

It must be remembered that the grounds upon which we sought the loan were that it would be utilised to a considerable extent for the re-equipment of our industry, with the object of increasing our productive capacity.

On the 28th January, however, the Chancellor of the Exchequer reported to the House of Commons the manner in which the loan had so far been expended, indicating that 56 per cent. had been spent on food and tobacco, and only 11 per cent. on raw materials and 5 per cent. on machinery—the remainder on other items. Furthermore, according to another statement made by the Chancellor of the Exchequer in December, rising costs in America since price controls were removed have depreciated the purchasing power of the unused portion of the loan by 23 per cent. It is true that the peak of such prices may have been reached and that a drooping tendency may develop; there have, in fact, already been signs of a decline during the past few weeks.

We are told also that a further liability has emerged which will necessitate utilising, over a period of three years, one-seventh of the total amount of the loan towards the joint maintenance of our zone and the American zone in Germany. It is hoped, however, that this will not be a dead loss, but, as a contribution towards re-establishing the economic life of Germany, will ultimately be beneficial to our own economy.

These factors in themselves are disappointing, but for many months the general position in America has not been reassuring. Many of us imagined that, when the war ended, America, with her great industrial potential, would run into a period of

prosperity which would have its beneficial repercussions throughout the whole world. We have so far seen a very different picture, however, as that great country has been beset with labour difficulties, resulting in innumerable strikes in all sections of industry, which means, so far as we are concerned, that the raw materials and new machinery so urgently needed for our speedy reconstruction have not been available. The Americans, however, are a very resilient people and may well stage a rapid recovery if their difficulties with labour can be overcome; there are already indications of an improvement in that direction.

I have recently spent a month or two in America, and I left with a feeling that the immediate industrial outlook was not very promising. One cannot help being fearful that, if the necessities for our reconstruction are not forthcoming within a reasonable time, we may well have spent our dollar loan on food at rising prices, and other things, to the detriment of our industry at home.

As I mentioned previously, we are committed to an additional expenditure in Germany of some $650 million over three years, representing one-seventh of the total—a commitment which apparently could not have been foreseen when the loan was arranged.

Considering all these matters, I do not think that those of us who were optimistic at the outset can look for the measure of financial aid for reconstruction through the dollar loan for which we had originally hoped. Nevertheless, we must recognise that the loan has enabled us to live, as without it we should have been in a parlous condition.

The Part Finance can Play and the Possibility of Meeting Industry's Requirements

Let us turn now to our main problem. We all desire to see the whole of our industry established on up-to-date lines, highly efficient, able to produce at prices which home consumers can afford to pay, and able to stand the test throughout the world against the severe competition which will have to be faced in the near future. It is only on this basis that we can expect to regain our pre-war standard of living, or hope to improve it.

While industry has been confronted with the problem of reconversion from war to peace-time production, much more is necessary in many instances than mere reconversion. New methods of production have emerged, necessitating new types of machinery, the introduction of which is necessary in order to counterbalance the shortage of labour, and many factories need modernising to provide, as they should, better working conditions and amenities for their employees.

In facing the future, industry could not have embarked upon vast schemes of reconstruction immediately on the cessation of its war production; it had first of all to reconvert to produce its normal peace-time products, regain its markets and consolidate its position. When it has passed through the transition period, it can then give urgent consideration to bringing into operation its plans for reconstruction and development, and explore the means for carrying them out.

We might summarise the financial requirements of industry under the following headings:

(1) The acquisition or building of new factories.

(2) The modernisation and extension of existing factories.
(3) The acquisition of specialised or modern machinery.
(4) Research and technical development.
(5) The reconversion from war to peace-time production.
(6) The acquisition of stocks of raw materials, etc.
(7) Temporary losses during reconversion.

Some of these items are in respect of permanent capital expenditure and others are of a more temporary nature, requiring temporary financial help.

Before I consider the various financial facilities which are available to industry, there are other more important factors to which I must direct your attention.

Although I cannot speak as an economist, it is impossible to obtain a balanced appreciation of the position unless we realise that, under the conditions at present existing in this country, money is not the primary essential in our economic reconstruction. Of much greater importance are the availability of raw materials, labour, modern plant and machinery, and, in addition, there is the problem of the productivity of labour. This aspect of the situation is made abundantly clear in the White Papers recently issued by the Government, but I fear that its significance is not very widely realised.

It may appear paradoxical that a banker should place finance or money in the last place on the list of priorities for our reconstruction programme, but I firmly believe that if I did not do so I should be misleading you. Finance can and will play its part at the appropriate time, but without a plentiful supply of raw materials, a keen and efficient labour force with a high degree of productivity, and the availability of the new plant and machinery which we need, money cannot make any useful contribution to our reconstruction programme.

There are very many companies which have the necessary finance, and others which have already made all the appropriate arrangements to procure it, but they are handicapped by the unsatisfactory position in regard to the various items which I mentioned, and so are frustrated in their endeavours to carry out their programmes.

I think it would be true to say that, so far as reconstruction has progressed, there have been no major operations which have been retarded by the lack of financial facilities.

Without going too deeply into the problem, it is clear that the new physical resources available for all capital purposes cannot exceed what is saved from current consumption out of current production, apart, of course, from net imports from abroad. Any attempt to overcome this limitation by the application of additional finance can only result in an inflationary rise in prices. From this point of view, the most important element in the situation is the willingness of the community to continue the saving habits built up during the war. It is in fact necessary that there should be a further net saving if finance for reconstruction and re-equipment is to be effectively available and further inflation avoided.

If, on the other hand, the public is disposed to realise past savings, for purchases of either capital or consumer goods, the Government may be compelled to borrow from the banking system to finance the resultant disbursements. This state of affairs is obviously unfavourable to the provision of finance for capital purposes without a further process of inflation. The pursuit of a cheap money policy at this

juncture has a very important bearing on the problem if it tends to reduce the incentive to save.

In March, 1945, the *Economist* put the position very aptly, and the following is an extract from the article referring to a two- to five-year post-war period:

> "In this period there will be a famine of physical but not financial capital. The danger in this period will be lest current consumption and the needs of the Government should, between them, engross too large a share of the national output and leave far too little to meet the needs of the community for the replacement and increase of its capital equipment".

Another most important factor is the trend of our export trade. If we do not succeed in exporting as much as, or more than, we import and thus eliminate our adverse balance of payments, we may well be forced to reduce our imports, which, if it meant a curtailment of the import of raw materials, would seriously retard our Economic Reconstruction.

It is imperative that all these various aspects of our economic situation should be realised, and if they are, then money will be relegated to its proper position, which is the very last item on the programme.

Some Financial Commitments of the Government

Perhaps, in passing, we might glance at some of the financial problems facing the Government.

There is housing, which is a high priority and will necessitate heavy borrowing by all local authorities—the bare requirement over a period of years will not be less than approximately £1,000 million, and may be much more.

The Minister of Fuel and Power estimates that the modernising of the coal mines will require £150 million.

The railways will need a large sum for overtaking arrears of maintenance, but they have provided approximately £120 million for that purpose; it is probable, however, that a much larger sum will be required.

The nationalised electricity industry will have powers to expend £750 million.

We know that the Government has heavy demands to meet some time in the future in respect of war damage insurance, post-war credits, excess profits tax refunds, and its extensive schemes of social services.

With these formidable commitments ahead, one naturally wonders where trade and industry will find a place in the queue, but no doubt the Government are fully alive to the paramount necessity of getting our industry into a healthy condition and will, perforce, have to give it an opportunity to acquire the financial aid it needs for that purpose. It seems to be perfectly obvious, in view of the financial problems to be faced, that careful control of the use of the available resources is essential, a duty which, in so far as industry is concerned, falls upon the Capital Issues Committee.

Referring to the various requirements which I have mentioned, and considering also the needs of industry, it looks very much as though it will be necessary to raise, in one way or another, somewhere in the region of £1,000 million annually for a period of at least five years, or may be longer, if the requirements of the Government and industry are to be satisfied.

This figure may sound astronomical and is, of course, greater than the estimated annual national savings, which are placed somewhere in the region of £500–£600 millions. While that deficiency might be corrected by budgetary methods, it is more likely, in view of our present economic position, that our reconstruction programme will have to be extended far beyond the five-year period. The effective realisation of the programme, however, will be dependent upon the volume of money which the Government may choose, through its own policy, to make available for industry, and the position in regard to production and savings.

Methods of Finance

Bearing all these important factors in mind, and particularly that money is not the foundation stone upon which our Economic Reconstruction rests, let us now consider what avenues are open to industry for obtaining its share of the available finance. The following is a brief summary:

(1) Capital market for new capital issues.
(2) Joint stock banks.
(3) The two new finance corporations, with joint available resources of £170 million:
    (*a*) Finance Corporation for Industry, Ltd.
    (*b*) Industrial & Commercial Finance Corporation, Ltd.
(4) Other finance houses in the City.
(5) Development Areas Treasury Advisory Committee.

Capital Market

Considering first the possibilities of the new capital market, the total resources of the clearing banks have increased since 1938 from £2,250 million to a figure of £5,685 million, and, therefore, there would appear to be a considerable amount of money available for suitable investment.

In this connection it is well to remember that to destroy credit, once it has been created, presents innumerable difficulties. After the first World War great efforts were made towards that end, but no more than approximately 8 to 10 per cent. was destroyed, and the result of the effort was disastrous to our economy. I think it can be assumed, therefore, that, under the present Government's policy, the bulk of the bankers' deposits will, with seasonal variations, remain at not much less than their present dimensions, but with an expansionist policy persisting may well show further increases.

The market for new capital issues is open to those who can claim priority in the national interest. As I have mentioned, this procedure is controlled by the Capital Issues Committee, under the guidance of the Treasury. I repeat that we do not know, of course, how far the Government may monopolise the capital market, either for deficit financing or in connection with its borrowings for the reconstruction of its nationalised industries, but some freedom is inevitable and there is, therefore, a considerable volume of funds available for those companies with a good record, which are large enough to use this means of financing their programmes.

Although we appear to have seen many new issues appearing during the past few months, those actually providing new capital in 1946 only amounted to approximately

£131 million, whereas in the 1920's they averaged £267 million. If we allow for the rise in prices, the difference between those years and 1946 is much more marked.

The possibility, or otherwise, of raising money in this way, however, depends upon the industrial prosperity of the country and public confidence in the future. If we could count upon five years of expanding trade and a high standard of labour productivity, I feel that all the larger companies could get their requirements through the capital market, and a movement of this kind, with proper control, need not be inflationary.

BANKS

In considering other available resources for industry, the position of the large joint stock banks should be examined. As I have already mentioned, in the year 1938 the total resources of all the clearing banks amounted to £2,250 million, out of which loans and advances were £966 million. On the 31st December, 1946, the total clearing banks' resources were £5,685 million, and the loans and advances amounted to only £980 million.

It will be observed, therefore, that with total resources two-and-a-half times as much as in 1938, the loans and advances are very little greater than in pre-war days, in spite of higher prices. Theoretically—I would stress the word theoretically—therefore, it might be said that there are available at the banks facilities amounting to roughly £1,500 million, if we take the percentage of 1938 lending and apply it to the 1946 resources.

The question naturally arises, however, as to how the banks can provide these facilities if they cannot dispose of a large portion of their holdings in gilt-edged securities, or if the Government does not relieve them of their Treasury deposit receipts. Does not the answer depend upon the policy of the Bank of England and the Treasury? If it is an expansionist policy, which it certainly is at the present time, then if we agree with the theory that in a confined banking community, every loan, generally speaking, creates a deposit, except in cases where a loan is repaid, it could certainly be achieved, but this trend would become inflationary unless the present physical controls over spending were retained, *i.e.*, unless there was an adequate volume of national savings. That, however, is assuming that the banks could not dispose of any of their gilt-edged securities, but it is often overlooked that the National Debt Commissioners, who have the responsibility for dealing with and investing the surplus funds of the Post Office Savings Bank, Trustees Savings Bank, and National Health and Unemployment Funds, have large sums annually at their disposal for investment. During the past five years Government issues made specifically for the National Debt Commissioners amounted to £1,532 million.

If, therefore, no new Government borrowing, or only restricted borrowing, took place, very substantial holdings of gilt-edged securities could be taken from the market through that channel.

By a gradual process, the banks, in my judgment, could go a very long way over a reasonable period towards providing some portion of the sums required for reconstruction purposes. This, of course, assumes that the borrowers be credit-worthy and that the banks would not be expected to provide a large measure of long-term capital, but I will refer to this aspect later.

When directors of companies have under consideration reconstruction problems, coupled with the financial requirements to carry out their programmes, it will generally be found, particularly in the case of the smaller companies, that preliminary discussions are commenced with the companies' bankers. After all, the banker probably knows the history of the company and the ability of its management, and can form some judgment in regard to the programme which is presented. You are well aware, no doubt, that a banker's normal function is to assist trade and industry in its seasonal or general trading business, and to provide means to acquire a stock of raw materials and a stock-in-trade—in other words, to provide a measure of working capital. It was never considered part of a bank's function to provide money for capital assets, but, since the end of the war, banks have been willing to broaden their views in this respect within reasonable limits. There is no particular "yard stick" by which assistance of this nature, which bankers may afford, can be measured—it naturally depends upon the history of the company and its managerial efficiency, and the possibility of repayments over a reasonable period of time. With the increased measure of liquidity which very many companies now enjoy, they may well embark on capital expenditure out of their liquid resources and look to their banker to supply their financial requirements for current trading.

Other Avenues

The large industrial concerns have many facilities available, either through the capital market, from their own resources, or through their bankers. There is also the new Finance Corporation for Industry, which was formed a short time ago and in which the insurance companies and the investment trusts are interested. This Corporation will consider requests for long-term advances to companies which require accommodation of *over* £200,000. But there are over 3,000 industrial public companies in Great Britain, besides many private companies and firms, all of which come into the picture, and the majority might be considered comparatively small.

The larger industrial concerns can, generally speaking, take care of themselves, but there are innumerable smaller undertakings which cannot go to the capital market and must perforce seek other ways and means. I have already mentioned that some companies have ample resources to cover their reconstruction requirements, and others can provide a considerable proportion of their needs, but we must consider those which are not in such comfortable circumstances.

To these smaller entities, which, after all, are a very important section of our industry and economy, the problems of reconstruction and modernisation are very real. The great majority did a grand job in war-time production, their managements learned a good deal about costing, efficient control and production, and very many of them extended their productive capacity far beyond the capital resources normally at their disposal. Many of these companies need a measure of permanent capital, and a second finance company has been formed, in which the banks are the shareholders, called the Industrial & Commercial Finance Corporation, which is prepared to consider providing long-term loans or making additional capital available up to a maximum sum of £200,000. There are also other institutions in the City which will consider affording similar assistance. It must not be overlooked that the funds

at the disposal of the finance corporations and the other finance houses, apart from their capital and reserves, have to be provided by loans from the banks.

In the case of companies which decide to operate in what are known as the Development Areas, such as South Wales, the North-East Coast, parts of Scotland and one or two other areas, and which are unable to obtain financial assistance either from their bankers or the finance corporations, application for financial accommodation may be made to the Development Areas Treasury Advisory Committee.

I think, therefore, it would be true to say that with the capital market, the banks, the two finance corporations, other finance institutions and the Treasury Committee, the means for obtaining money for reconstruction and development purposes can be made available at the appropriate time to all classes of worthy borrowers.

Excess Profits Tax Refunds

Another important factor which has to be borne in mind when considering available finance is the repayment to industry of 20 per cent. excess profits tax, less income tax, which the Government have promised to provide, and, in fact, are paying, for the purpose of rehabilitation and reconstruction. This payment cannot be used for purposes such as paying dividends, but must be utilised for the development of the business.

The total excess profits tax paid since 1940–41 to the 31st December last was approximately £2,300 million, a portion of which will no doubt have to be refunded in respect of losses incurred during the transition period, but an official estimate gives a figure of £450 million, which, after deduction of tax, amounts to £247 million returnable to industry—a substantial contribution towards reconstruction. It is interesting to note that of that net sum of £247 million, £167 million has already been distributed.

Conclusion

One would hesitate to compile an arithmetical sum of the available funds that may flow to industry from the various sources to which I have referred, and there is no object in doing so because I have no hesitation in stating that, given the physical requirements, industry will have no difficulty whatever in procuring the essential finance.

The fact that the available financial facilities which I have mentioned have not been utilised to any extent is not because financiers or bankers are unwilling to lend, but for the reason that industry cannot obtain its physical needs and, therefore, has no immediate necessity to seek additional financial aid. The position has been aptly described in the following sentence:

> "Finance is but a lubricant; it does not, it will not and it cannot provide the motive power".

Although I have been asked to speak on Finance and the Use of Money in connection with our Economic Reconstruction, I am sure you will appreciate that I could not ignore the other more important aspects of the general economic position with which we are faced in this country.

In considering all these questions, it is essential to stress again the ever-present danger of inflation, which is bound to confront us for some time to come.

We naturally hope that this year the Budget will be nearly balanced and that deficit financing will cease, and also that there will be no further Government borrowing for the pursuit of the cheap money policy.

Industry has difficult and strenuous times ahead, and while it is inevitable that financial and physical controls should be maintained for the time being, it is incumbent upon those who exercise them to ensure that the wheels of industry are not clogged with officialdom, and that every effort is made to eliminate the innumerable bottlenecks which exist in every department.

It is quite impossible for anyone to be dogmatic in regard to all these problems, as public sentiment, the progress of industry in the next few years, the supply of labour and raw materials, the productivity of labour, the condition of our export trade, the international situation, the rehabilitation of Europe, particularly Germany, and the policy of the Government, are all factors which will contribute to the success, or otherwise, of our ultimate Economic Reconstruction.

DISCUSSION

Mr. E. MUNRO RUNTZ: When the Government resorts to the capital market to finance deficit borrowing, does that necessarily mean further inflation?

Mr. H. N. HUME: May I ask Mr. Ensor to elaborate one point, which I think was implied when he said that the physical requirements of industry are more important than finance, which to-day follows almost automatically to credit-worthy concerns? I submit that included amongst the physical requirements is management of the highest order by individuals who have skill, knowledge, integrity, and honesty, who are trained and willing to manage the businesses concerned, and indeed, guided largely by a spirit of service rather than that of monetary reward, because of the incidence of personal taxation.

Mr. E. G. MUNDELL: I was very interested indeed to hear the speaker's remarks about the American Loan. Curiously enough, I attended a meeting last night at which the same subject was discussed, and Mr. Ensor's explanation that the machinery and raw materials are not available in America at the present time on the scale required by this country, is the first I have heard as to why so little has been expended on those very important items. I think all of us here realise how very important the American Loan was and is to the well-being of this country over the next two or three years. One therefore might justifiably have said, if this plant and machinery in America is not available at the moment, would it not be far better if the Government had reserved some of those dollars to buy this machinery when it is available, instead of spending such an apparently large proportion on tobacco and films? It seems to me we have gone to America and said, "We want this Loan to rehabilitate our industry", and then we do a thing which I think no prudent business man would do, that is, we borrow money as capital and spend it as income.

The second point which I wanted to raise is this. Mr. Ensor has rightly emphasised that the banks have not been in the past (and, as I understand it, they will not be in the future) very interested in providing long-term capital, but it does seem to me to-day that as our paramount requirement is the re-equipment of industry, it is long-term capital which is required. I seriously wonder whether the resources which Mr. Ensor has told us are available, apart from the banks, are anything like adequate for this purpose.

Mr. T. C. NORRIS: As an ordinary member of the public, I cannot help thinking that

the emphasis on the export trade has been over-stressed. I think the most important matter that we have to face is the rehabilitation of our own industries, because unless we can equip our own industries with better machinery, we cannot sell at a competitive price abroad. The consequence is, the first thing we must do is to re-equip our own industries in order that we may compete anywhere. But, you will say, how are we going to get the money to do it?

In the past England has been a creditor nation always, and she has always stepped into the breach and helped the debtor nations. Now we are a debtor nation. Why cannot we go to the creditor nations of the world, from whom we must import vital raw materials, and say: "Look here, we will be hard up for three or four years, and we really want loans, and why cannot you concede us a credit for, say, four years?" For, if such a scheme were to be arranged by the financiers, we could temporarily forget about exports and be free to devote our entire resources to the rapid re-establishment of our own industries.

Mr. C. H. STARR: The recent White Paper has made repeated references to the need for more effort. It reads very much like some of the wartime exhortations. The situation, it appears to me is entirely different from what it was during the war, when it was a case of production at any cost; and a very important point has been missed by not stressing the need for lower costs. In the future, this country, if it is going to exist, has got to export, and do so on the grounds of competitive price, excellence of design, and quality of products.

The White Paper refers to methods of payment as a means of getting increased output. During the war, what I might call "piece work schemes" were introduced in a number of cases. In many cases they gave increased output, but they were frequently so badly applied that they did not increase output as much as they might have done, and they often raised costs. A previous speaker mentioned the need for skilled management, and I think this is a case in point.

Mr. W. J. WILLIAMSON: Will Mr. Ensor give us some information in regard to the opening up of the Japanese economic exports under the American administration, and how it will affect our own export of the cheaper class of goods, especially textiles?

Mr. A. H. ENSOR: I will not deal with any of these questions at great length.

The first question was whether deficit financing increased inflation. The answer is definitely "Yes". Whether the economists would agree with me I do not know, but I would say "Yes" every time.

With regard to the second question on physical requirements being more important than finance, I think the answer there is definitely "Yes", and the question of efficient management is a most important factor.

The third question was on the American Loan and the Government policy. Well, I would rather hesitate to discuss that at this moment, because I gathered the speaker is rather critical of the manner in which the Loan has been spent, and I did say at the time, I was not criticising the expenditure of the Loan, but rather emphasising the fact that we could not get what we required. I think it might take quite a long time if we started arguing on how it was being spent and why, because we would get into a lot of economic arguments.

With regard to the next speaker, who suggested that we went cap in hand to all the people who had got money all round the world, I hope we do not have to do that. We may have to make some effort later on, but I should deprecate taking that step at the present time.

The gentleman who referred to the contents of the White Paper: I think one can sum up all he said in one word, and that is, "incentive". Whether you can increase your production by finding some means to encourage the worker, by giving him some

incentive, whether in consumer goods, or some promise for the future, I do not know, but it is one of the most difficult problems that has to be faced at the present time.

With regard to Japan, I will have to ask the last speaker to find someone who can answer the question, because I am quite at sea on that particular subject at the moment. If there is anyone in the room who would like to answer it, I would be delighted.

Mr. E. G. MUNDELL: I can give some information on that. I happen to be connected with a business which is prominently connected with our export trade to one of the Dominions. To-day we received a circular from one of our branch offices overseas to the effect that the American Zone in Germany were now ready to receive offers from buyers for German textiles. We have had quite an interesting list of prices which they want for these things, and we are studying the problem ourselves. We also understand that Japanese textiles will be available shortly.

THE CHAIRMAN: It will be the desire of you all, I know, that I should tender our warmest thanks to Mr. Ensor for his paper. I need not conceal from him that we had formed very high expectations of the interest of hearing a paper on this subject from one in his most central position, and we have indeed not been disappointed.

There is very great influence in the hands of those who are responsible for the management of the policy and the practice of the great banks, and it is indeed most encouraging to those of us who seek anxiously for a way out of the present difficulties of our country, to learn, as we have learned to-day, what deep knowledge, what careful research, and what public spirit there is in the minds of those who occupy such positions as Mr. Ensor.

I pricked up my ears when he referred to the Capital Issues Committee. The Committee, by the way, exercises no executive power, and no control: it is only an advisory committee of the Treasury, and—and this is relevant to what Mr. Ensor was saying—the control exercised by the Treasury through the Capital Issues Committee on the direction of investment money, is only one of two controls, the other of which is certainly not less important, namely, the control exercised by the great banks. The Treasury control through the Capital Issues Committee has always sought not to put its finger in the pie of the banks' business, and their ordinary relations with their customers, by way of the advancement of funds in the ordinary course of business. The efficiency of control of the course of investment therefore depends on the great banks to a very large extent, and I should like on this occasion to pay my tribute, having watched the exercise of that control by the banks throughout, to the fidelity to national policy shown by the great banks in carrying out the desires of His Majesty's Government from time to time, without compulsion, without regulation, without legislation, simply by desire to co-operate, on the basis of the well-known phrase "the gentlemen's agreement".

Most heartily we thank Mr. Ensor for his paper to-day, and the instruction we have received from it.

Mr. ENSOR: I will not detain you except to thank you, my Lord, very much for proposing that vote of thanks, and to you all for listening so patiently to what I had to say. I would acknowledge the very kind tribute of Lord Kennet's to us poor bankers, because we have, in truth, endeavoured to do what we should do, and fortunately, so far as I know, we have not been reprimanded very strictly from high quarters.

Mr. E. MUNRO RUNTZ: I am sure you would not wish to leave without passing a vote of thanks to our Chairman tonight, Lord Kennet, not only for his kindness in presiding, but for finding the time so to do.

The vote of thanks was carried with acclamation, and the meeting then terminated.

THE DOON SCHOOL

By A. E. Foot,

Headmaster, the Doon School, India

Joint meeting of the India and Burma Section and the East India Association

Thursday, January 16th, 1947

Sir Harry Haig, K.C.S.I., C.I.E., *in the Chair*

The Chairman: We are to hear to-day a paper on the Doon School, written by the Headmaster, Mr. Foot. Unfortunately he is not able to be here to-day because he is at his post in India, but the paper will be read for him by Mr. Jamsheed Rahim, one of his old pupils who has recently come over here and is at present at Cambridge.

The Doon School represents a very important experiment in India. For many years a number of leading Indians had felt that the Indian educational system was to some degree lacking in those elements that go towards the formation of character and leadership, in fact precisely those qualities which the English public school system is designed to foster. Some Indians, men of position and wealth, met that situation by sending their sons to public schools in this country. But it was not really a success. The boys tended to lose their roots, and when they returned to India they seemed to be only half Indian. The ever present contrast between the two systems of life and culture made for unsettlement in their minds. If they swung to the English side they lost authority and influence with their own people, and if they swung to the Indian side they felt the more acutely, because of their past equal association with the English, the fact that in their own country they were not self-governing. So if the English public school system had anything to offer to the development of India it was clear that that contribution could only be made by establishing the system in India, and adapting it to Indian conditions, so that boys could be educated with the essential elements of that spirit which the English public school provides, but as Indians and in their own country.

Those ideas were felt very strongly and pressed very actively by Mr. S. R. Das, who was Law Member of the Governor-General's Council. By his activity and initiative he raised a considerable fund and a great deal of interest was roused throughout the country; but unfortunately, on his lamented death, the scheme languished for a time. It was rescued from shipwreck by Sir Joseph Bhore, and he was supported by another old colleague of mine, who I am happy to see here to-day, Sir Frank Noyce. Between them they got the scheme launched, I think in 1935, and they launched it in that paradise of Government of India institutions in my own Province, at Dehra Dun.

I was fortunate enough, soon after the school started, to visit it on the occasion of the first Anniversary of Founders' Day. I shall be very much interested to hear what progress has been made since then, for that was over 10 years ago.

I should like to say a word about Mr. Foot. As I was explaining, the idea of the School was to introduce the principles and underlying spirit of the English public school into an Indian institution. For that purpose Mr. Foot was by his training and experience well fitted. He had been educated at the oldest of the great public schools—a privilege which I also shared—and later on he became Assistant Master at Eton. Eton and Winchester are two names, than which none could be more typical of the English public school, and that is what Mr. Foot had behind him in his task. You will hear in the paper what the work is that he has been doing in these past years.

Mr. Jamsheed Rahim then read the following paper:

In 1928, Mr. Satish Ranjan Das, cousin of the nationalist leader C. R. Das, became Law Member of the Viceroy's Executive Council. With the encouragement of the Viceroy, Lord Irwin, he used a considerable amount of his time and energy in arousing interest and enlisting support for the establishment and proper

registration of the Indian Public Schools Society. The object of this Society was to establish in India boarding schools of the same type as the English Public Schools, in which there should be no distinctions of caste, creed or social status, and Mr. S. R. Das aimed at raising 40 lakhs of rupees for the establishment of one school, that would be the forerunner of many others for both boys and girls. Mr. Das died in the same year, 1928. He had collected 10 lakhs in cash, and had promises of another 10 lakhs, and had formed the Indian Public Schools Society under the Companies Act. After his death the committee of management, with frequent changes in personnel, were not able to do very much, and early in 1934 some of the donors of the 10 lakhs began to suggest the return of their subscriptions. But fortunately Sir Joseph Bhore, then Railway Member of Lord Willingdon's Council, undertook the Chairmanship of the Committee, and with Mr. M. S. A. Hydari (now Sir Akbar Hydari) as Secretary, decided that this must not occur and that a site must be found and a school started with the funds available, which with interest had by then amounted to 14½ lakhs.

They obtained from the Government of India on favourable terms the site at Chandbagh, Dehra Dun, which had been left vacant when the Forest Research Institute moved to new quarters, and put forward a definite scheme which was accepted by the Society in August, 1934. Lord Halifax, then President of the Board of Education, was asked to convene a selection committee to appoint a headmaster, and the writer of this paper, who was at the time an assistant master at Eton College, was selected. The headmaster arrived in India in February, 1935, and the school was opened in September, 1935.

For the first term there were seventy boys between the ages of eleven and fourteen. In the second term, starting in February, 1936, there were 110 new boys, ranging down to a minimum age of eight. In subsequent years the minimum age limit was raised gradually to eleven, so that the age range at the present time is eleven to eighteen. In 1937 a fourth house was added, and since that time there has been no major change in size, though the existing structure has been stretched so that there are now just under 300 boys. There are four boys' houses, named after the biggest initial donors: Hyderabad, Jaipur, Jammu and Kashmir, and Tata. Each house holds sixty-eight boys. Fifteen are accommodated in a holding house for boys in their first term, and there are about ten day-boys—all sons of genuine local residents. There has never been any lack of demand for places in the school and the waiting list is full up to 1953. There are over 100 names on the list for each term for the next five years, out of which not more than a quarter will be able to get in.

The fees in 1935 were 1,375 rupees a year. In 1938 they were raised, for new admissions, to 1,525 rupees. In 1941, owing to the overall rise in prices, a charge of 100 rupees was added for all. From September, 1946, the fees have been raised again, for new entrants, to 1,800 rupees (£138) a year. The fee is very inclusive, and with pocket money (limited to 8 rupees per month) clothes and travelling, a parent should not need to spend more than £170 a year.

About 60 per cent. of the parents are professional men or in Government service. About 20 per cent. are business men and the remaining 20 per cent. landowners or princes. The boys come from all over India.

There are no scholarships. Although in some cases states or individuals have

financed the education of boys, so that there are always a few boys whose homes are comparatively humble, the school has no funds with which it could give scholarships. Boys are admitted simply on the priority of their application, provided always that they are up to the educational standard of the bottom class. As the teaching throughout is in English, it is necessary that a new boy should be able to follow simple English.

Boys take the Cambridge School Certificate examination usually when they are between 15½ and 16½. Except when the upper age limit interferes (a boy may not stay beyond the end of the school year in which he becomes 18) most boys stay on after the School Certificate, and work either for the U.P. Intermediate or the Cambridge Higher School Certificate. The Intermediate can be taken 15 months, and the Higher School Certificate two years, after the School Certificate. The majority of boys choose to do Science subjects, either Physics, Chemistry and Mathematics, or Physics, Chemistry and Biology. The Arts subjects are Economics, History and Civics. Most boys on leaving go to a university in India. About a dozen are in England now and the same number in U.S.A. Other boys go direct into one of the armed Services or into business. At the end of the war about 65 old boys had commissions in the Indian Army, Navy or Air Force.

In language we have never intended to base our instruction on the Classics in the way that Latin is still the centre pin of the English Public School. The great majority of boys take Urdu or Hindi, and they take them at the higher of the two standards arranged by the Cambridge Board. Until recently the Cambridge examination has had the reputation of admitting a credit in Indian language for work well below that of an Indian Matriculation. But now the syllabus and standard of Higher Urdu and Higher Hindi is fully equivalent to the Indian Matriculation. We do not allow boys to take the lower standard, except for a few for whom they are new languages and who are otherwise very backward. Boys can also learn, with arrangements made by the school, Bengali, Gujarati, Marathi or Tamil, but this has to be done out of school hours and 10s. per month is charged. Any such boys must also do Urdu or Hindi until they have reached a reasonable standard, but they can give them up for a year before the School Certificate, for which they can offer the special language.

Actually, in the history of the school, we have had far more difficulty in improving the standard in Indian languages than in English. Many parents are extremely neglectful of their own mother tongue; they are urged to write to their sons in it and insist on replies in it but, I am afraid, without much effect; the majority find English much more convenient. Masters in their language periods are instructed to use no English at all, and they are also encouraged to talk to boys out of school in Urdu or Hindi. There are three language societies to encourage debating, story-writing and reviews of the work of Urdu or Hindi authors. Moreover, whereas in the early days it was thought necessary to urge on parents the need of making their sons somewhat familar with English before they came to the school, now it is more urgent to impress on them the need of a good grounding in their mother tongue. It is also of interest to note that in most cases the boys who are most correct in their Urdu or Hindi are also most correct in their use of English. In fact, I feel it is perfectly possible for boys of the type who come to the Doon School to be absolutely

bilingual, and that proficiency in one language has no adverse effect on the second one, but rather the contrary.

The results in the Cambridge examinations have always been satisfactory; about 50 per cent. of the boys get 1st grade certificates and about 15 per cent. are unsuccessful at their first try. Only well-equipped boys are encouraged to take the Higher Certificate and they are usually successful.

We have a well-equipped workshop for carpentry and metal work with four old motor-cars and two wrecked air-frames, with their engines; there is an art school in charge of a well-known Indian artist, who also has a stone-carver and book-binder working under him: there is a music school in charge of an Indian music master of wide interests. Boys below the School Certificate class spend school periods in the workshop, art school and music school. The workshop and art school are open and available for work on Sundays and half-holidays, and boys who are keen do a considerable amount of work in their free time. At the end of each summer term we hold an exhibition; the term's production in workshop and art school is on view, and there is an exhibition of scientific experiments in the Physics, Chemistry and Biology laboratories. Other departments—Geography, History and Language—usually have an exhibition at the same time. The day finishes with the inter-house music competition, for which each house trains an orchestra, a senior and junior choir and a soloist. Nowadays about 150 boys altogether take part in the house music competition.

The games played at the school, and in which there are school matches and inter-house competitions, are hockey, Association football, cricket, athletics, lawn tennis, swimming, boxing, Indian wrestling and cross-country running. These are spaced out through the year, so that at any period there is one major game and one minor game in season. There is P.T. daily in the early morning. All the classes are taken by senior boys, who have a course of training in leadership somewhat analogous to that for Certificate A, Part I, in the O.T.C. in England, and all boys have to do this course so that those who are lacking in self-confidence get a chance to develop it. Senior boys also teach new boys to swim, and later on give the instruction for the Royal Life-Saving Society's Certificates. There is also coaching in boxing, wrestling and athletics in the P.T. period.

We have a system of badges on the lines of the English county-badge plan which was, unfortunately, still-born some years ago. We have formulated three standards, called bronze, silver and gold, in athletics, apparatus work and swimming and each boy has a card on which his record in the tests is kept. When he has passed the tests in all three activities he receives a bronze, silver or gold badge, and, of course, is likely to qualify gradually to the higher standards as he stays in the school. These badges encourage a boy to pay attention to his physical development, even if he happens not to be much good at ball games, and to get the satisfaction of definite accomplishment.

Although coaching from masters is available in all these physical outlets, the senior boys are mainly responsible for teaching the mass of boys. As boys train their teams for house competitions, there is ample scope for boys to get some experience in leadership.

There are a variety of school societies which, for the most part, meet in the

evenings, fortnightly, and, where appropriate, have lectures from outside people or boys—Scientific Society, Literary Society, Historical and Economic Society, Senior and Junior Debating, Poorbi (Hindustani), Shama (a junior Poorbi), Bazm-i-Adab (more highbrow Urdu), an Art Society, Musical Society, Colloquium (for serious Mathematics), Chess Club, Film Society, Natural History Society, a Philatelic Club, and the Crickets (somewhat similar to the Essay Society at Eton). There is the *Doon School Weekly*, of which the editorial board is made up of a master and a boy from each house. This contains, as well as the school news and fixtures, any news of old boys that is available. All members of the Doon School Old Boys Society, which now numbers about 300, receive this paper and it forms a most useful link with them. It now spreads very far over the world. There is a tuck-shop of which a senior boy is manager and others have a roster of duties as servers; the profits are available for grants to school societies for capital expenditure. The tuck-shop has two dozen bicycles for hire.

All activities of the school, other than the curriculum, are really responsible to the Doon School Council. This body is elected annually—four boys from each house, of whom one must be a prefect and one a middle-school boy—four masters, who are selected by the masters in rotation—and the headmaster, who is *ex-officio* Chairman. The Council meets every three weeks. Each school society has one of the members of the Council to answer for it, so that any criticism of a society can easily be aired. There is a Finance Committee which audits the accounts of all societies which must be kept in a standard form. The Council is responsible for the Social Service activities of the school, which are mainly centred in the Dehat Sabha and the Chandbagh Education Society. The Dehat Sabha takes an interest in the affairs of the village Tunwala, about five miles from the school. In the last eight years it has sponsored various forms of development in the village. It has built a primary school, and arranged for the training of a man from the village as a teacher. It arranges for periodic medical inspection, and keeps a medical chest there. It holds annual village sports, on one day for inter-village competitions in wrestling, volley ball, kabaddi, running, etc., on another day for the children at the school, and this includes an inspection of the village houses. Boys from the school visit the village at week-ends, and sometimes during the week, in order to see to the needs of the school and enquire into absence or sickness. A master directs their activities, and also has done a great deal to develop a panchayat (council) in the village and to bring their needs to the attention of the local government agencies.

The Chandbagh Education Society was started nine years ago primarily to encourage literacy among the school servants. After a time, this literacy was largely achieved, and a monthly news-sheet has been produced, in Hindi and Urdu, for the servants. This contains local news—as the Doon School servants form a body, with their families, similar to a village—and news of the world, and reports of the servants' panchayat. This has representatives of different classes of servants and meets periodically with the headmaster as Chairman to deal with applications for loans from the Servants' Co-operative Saving Society, matters of discipline, and grievances of the servants. The servants have a Panchayat Ghar (village club-house) with a radio set, and from time to time they hold meetings at which boys help by talks and lectures with a film-slide lantern.

The main work has now developed into conducting a primary school for the children of servants. Boys help in the instruction in this, though the main responsibility is with a paid teacher. The Society arranges for a lady doctor to visit the quarters periodically.

The School Council is responsible for raising money for the expenses of the Dehat Sabha and Chandbagh Education Society. A collection is made from the boys' pocket-money. This is more or less equivalent to an income-tax. This is augmented by the proceeds of plays produced in our open-air theatre for the public. Recently, as our expenses were increasing, the Council introduced a sales tax, whereby 10 per cent. of the profits of the tuck-shop, Film Society, and anything else that made a profit, should go to the Council's revenue.

During the war the Council controlled a War Chest, which allocated funds collected from the school to purposes connected with the war, mainly in getting books, gramophone records and other amenities for Indian Soldiers' hospitals. The War Chest has now become a Relief Chest, and makes contributions to Famine Relief and similar funds. The main responsibility, however, has been for financing Doon School Relief Parties. In the past four years six such parties have gone at the beginning of the school holidays to spend a fortnight in places affected by disasters. Three parties went to Contai in the Midnapore district of Bengal, one to the Kosi flood area in North Bihar and two to the area south-east of Calcutta affected by salt water floods in the Ganges delta. The Relief Chest pays third-class fares for the party and a small amount that can supplement the standard diet of dal and rice with some sugar, jam and butter.

The Council also controls a compulsory labour quota scheme. Each boy above the age of 14 must do a period of public service weekly. A boy is appointed as Labour Secretary to keep the records, and a Labour Committee is responsible for recommending approval of different types of work to count for a quota. These form a considerable variety. The quota may be discharged in work for the Dehat Sabha or Servants' School, or in social service on behalf of outside bodies—such as taking St. Dunstan's patients for walks and assisting the local Rotary Club in their weekly wash-day at local municipal primary schools—or in work for the school, in the mosquito control squad, collecting lost property, making the school ink and phenyl in the Chemistry Laboratory, practice for the school orchestra, rehearsing for school plays, addressing the *Doon School Weekly* and, for the largest single number, manual work on the " Grow More Food " campaign. This scheme is a great convenience. If a job needs to be done, the Labour Committee can be asked to provide boys to do it. Admittedly, it detracts somewhat from the voluntary nature of public service. However, before the labour quota was started, it was found that a certain number of boys would always be ready to volunteer whenever volunteers were required, and would be soon overburdened; and a very much larger number are quite happy to do work when there is a little stimulus, and possibly get accustomed to the idea that public service is a normal activity of life. The small number of shirkers find that a society in which the majority do their share, they will get no support from public opinion. Their conflict is not with the headmaster, but with the School Council.

Religion and discipline can logically be placed in the same section, as they are

both treated as a part of personal responsibility. There are boys of many different religious backgrounds in the school; out of 300 boys there are usually about 50 to 60 Moslems (who include Sunnis and Shias), 15 to 20 Sikhs and the same number of Parsees, half a dozen Christians, and the rest Hindus. There is no doctrinal religious teaching, but there is, daily, a School Assembly at which there is music from a gramophone, a prayer of a type that makes no assumptions about the after life but which centres round the development of the human personality and the recognition of its sacred nature, a period of silence, and a hymn, usually one of Tagore's or Iqbal's. From time to time the headmaster talks on some suitable topic. The prayers are mostly from Tagore or R. L. Stevenson; they are explained by the headmaster in his weekly period with the lower classes. Discipline is not based on any system of punishments, but we rely on the boy realising that the authorities of the school really care about the development of his character and his absorption of the ideals of the school and his acceptance of its standards of conduct. When a boy falls short of the standard either in matters of personal discipline such as punctuality, or in respect for the orderliness of the school, or in more serious things concerned with honesty in his work and his dealings with masters, he is likely to be seen by the headmaster. The headmaster will try and ensure that the boy realises where he has been wrong, and will usually give him a yellow card, which the boy has to get signed by his housemaster and tutorial master and return at a certain time to the School Office. After a week he has to get a discharge card from the office, get it signed again, and bring it to the headmaster who thus gets an opportunity to close the incident. During the period up to discharge, the boy is not allowed to go to the tuck-shop, or to go out of the school grounds. The restriction is not very serious and the yellow card is largely a symbol to indicate to the boy that he must do better. Moreover, as there is the same treatment of offences of varying gravity, the yellow card is in no way a payment like a fine or a hundred lines or a beating; the effect is subjective, and a boy who has a yellow card for something which is rather shabby will feel differently from the boy who has one for being late or forgetful. If a boy is idle at his work the Headmaster will give him a red card on which there is space for each period of the ensuing week and the boy has to get it signed by the master who has been taking him. At the end of the week he brings it to the headmaster, who will either give him another one or assume that he has been sufficiently reminded.

There are four school prefects in each house appointed by the headmaster, who sees them all together on Sundays at his house, so that there is an opportunity to discuss matters of importance that occur to him or to them. There are an additional four to six boys appointed by the housemaster in each house with jurisdiction over the affairs of the house. These and the prefects are allowed to go out to the town for shopping and an occasional cinema.

Recognition of merit does not take the form of competitive prizes. If a boy reaches a certain high standard in regularity of conduct, in industry at his work or in achievement in the terminal examinations, he will sign the School Honours Book. Every three signatures entitle him to a prize of a book. A boy may also be awarded school colours by the Council, on the recommendation of the Colours Sub-Committee, which consists of one prefect from each house and the headmaster.

They take into account anything which a boy has done which brings credit to the school. Eminence in the art school, workshop, school orchestra or plays, and in social service is weighed along with efficiency in games. There are usually about 25 to 30 school colour holders at the end of each term. In the main, school discipline is maintained by ensuring that as far as possible boys understand the reason for everything that takes place and that there should be considerable freedom of discussion.

In conclusion, there are three questions which are likely to occur to some or all of the audience. The first, perhaps the most mundane, "What about food?" The menu is a mixture of Indian and English food. There is no beef or pork and there is a vegetarian menu as an alternative to mutton and eggs. But the boys all feed together without any questions about who cooks or serves the food. The vegetarians make the choice on dietetic and not religious reasons. Boys who have not been accustomed to the taste or even the smell of meat, in due course usually try it and end up omnivorous. Other life-long meat-eaters sometimes feel that the vegetarian cook is more effective than the meat cook, and try a period of vegetarianism. There is a mess-committee of boys and masters in each house, and for the school, but in the last years this has been more concerned with the explanation of the need for economies and with suggestions of ways of making do with less sugar or flour without noticing it much.

The second question is "How do the boys compare with boys in an English school?" The answer to that is that those who know both don't really notice any difference. There is virtually nothing at the Doon School that would not be equally suitable for a school in any other country. Except that the background in art and music is in the oriental tradition, and boys wear Indian clothes from their own part of the country on formal occasions (they wear shorts and shirts for ordinary purposes) a visitor to the school would not find life very different from a public school in England. Some boys are bookworms; the majority prefer to play games or follow their hobbies. Some boys read the leading articles in the newspapers; the majority turn first to the sports news. Senior boys have the run of the headmaster's private books; some ask his advice about books on economics or education, but the majority take a P. G. Wodehouse. In reliability and a sense of responsibility the prefects can stand comparison with those of any English school. The boys value the school very greatly, and on an average a letter a day reaches the school from an old boy. They visit the school when they can, which often means a journey of six or seven hundred miles, and any of the staff can be sure of a welcome in almost any corner of India.

Now for the last question—the most difficult one: "How does the school fit into Indian life?" Firstly, in the political sphere, it has been very fortunate. There has been virtually no adverse press, and visitors range from the Viceroy to Jawahar Lal Nehru.* Secondly, in the educational sphere, although it is easier for the Doon School, with its income (which incidentally, is, to the extent of 95 per cent., derived from the fees, as there is no Government grant) to try new developments, it has considerable influence in two ways. Firstly, in raising the social and economic status

* This comment is rather out-of-date now that they are partners in the Central Government —*A.E.F.*

of the schoolmaster. Secondly, in putting ideas into the heads of the numerous visitors, whether teachers or managers of schools, of ways of doing things which are more satisfactory and involve organisation and energy rather than expense. In the social sphere, naturally a large number of people say that the school is too expensive and can only be accessible to the upper income groups. The reply to that is that the main cause of the expense is in paying the staff properly, and not in luxurious living. If public or private munificence would spend money on schools in which the teachers were paid enough to live a self-respecting existence, the educational standards of India could be transformed. In the meantime if only 300 boys can be at a decent school, it is more important that they should be rich boys than poor boys, as the rich have so much power for good or evil. If Doon School boys, or at any rate if a good proportion of them, leave school with the idea of an obligation to discharge their duty to society rather than to attain all the power and wealth to which education can open the door, it has done something useful.

The Doon School is by no means unique. In the last years many schools, formerly exclusively for those of noble birth, have opened their doors to those of a wider social class. And other schools are developing better educational standards through including character training in their programme, and through paying their teachers better. The heads of these schools belong to the English Headmasters' Conference, and they meet in India annually at one of the schools to discuss common problems.

DISCUSSION

Sir FRANK NOYCE, K.C.S.I., C.B.E.: I am sure that there are many here who are far more competent than I am to deal with the educational aspects of the most interesting paper to which we have listened. But I should like, in passing, to refer to the very successful way in which the School seems to have dealt with thorny questions of language, race, creed and caste and to the impressive account Mr. Foot has given us of what may be called the out-of-school activities of the boys. We have been able to judge from that how successful the School has been in one of its great aims, the development of character and of individual aptitudes. I cannot help thinking that, in some respects, the picture which has been presented to us of this side of its activities is well worth the attention of some of our public schools in this country.

My main object in speaking this afternoon is to amplify to some extent the references made by Mr. Foot and our Chairman to those without whose energy and enthusiasm the School could not have been brought into existence. As Mr. Foot has told us, its first founder was Mr. S. R. Das. When he died, the scheme languished for five or six years in spite of the tremendous efforts Mrs. Das made to bring it to fruition. As some of us know, when a lady sets her heart on getting something done, she usually achieves her aim, and Mrs. Das was no exception to that rule. She enlisted the warm interest of Sir Joseph Bhore and he was really the second founder of the School. When he became the Chairman of the Committee, in 1933 I think it was, the outlook was gloomy in the extreme. Funds amounted to only 14½ lakhs and some of the subscribers were so hopeless about the future that they were asking for their money back. Sir Joseph roped me into the Commiteee immediately after he became Chairman and I remember, shortly after I joined it, some of its members telling us that nothing could be done with so small a sum. It would only go part way towards erecting the buildings required and the very difficult question of site had still to be settled. Fortunately, both these questions, the question of cost and the question of site, were solved by the fact that the Forest Research Institute at Dehra Dun had been moved to another site and the old buildings wera still vacant. We were able to get them from the Government of India on most

generous terms. Our success in doing so may not have been entirely unconnected with the fact that Sir Joseph Bhore had been Secretary of the Education, Health and Lands Department to which the buildings belonged and that I was then its Secretary. We were, therefore, able to do a little to help in that respect. I remember spending a very happy day with Sir Joseph going over the buildings when we cast over in our minds the particular use to which each could be put. As the Chairman has said—and, though I did not serve in the United Provinces, I entirely agree with him—we were fortunate in getting an ideal site and in getting almost ideal buildings which could be adapted and extended with comparatively little difficulty and expense. Those of you who do not know Dehra Dun have been able to see for yourselves from the slides we have been shown what some of them are like, especially the main building of the Forest Research Institute, which is an exceptionally pleasing example of modern official Indian architecture. I do not remember who was responsible for it. I rather think it was Mr. John Begg when he was Consulting Architect to the Government of India. It is a very attractive building. And so we got the School going and were lucky enough to secure Mr. Foot as its first Headmaster. When I left India in 1937, by which time I had succeeded Sir Joseph Bhore as Chairman of the Governing Body and had been present at that first anniversary to which the Chairman has referred, I could feel happy that the School had an assured future. There is, however, one respect in which I am disappointed. I am sorry to learn from the account we have just heard that the School is still dependent on fees to the extent of 95 per cent. of its income. I am not so much concerned that it has no Government grant, but Sir Joseph Bhore and I had hoped that it would soon attract the favourable attention of some of the wealthy landlords and commercial magnates, many of whom have devoted considerable sums of money to other educational purposes, and that they would be following the example of those after whom the four school houses are named. If they were not prepared to contribute to the endowment fund, one could wish that they had spent some of their resources on founding scholarships. Perhaps it will not be long before some of the old boys rectify the omission.

And that brings me to my last point, which is that there is rather an important omission in the paper. We have been told that there are now 300 old boys. I should have liked to hear what is happening to those old boys—what careers they have chosen and how they are faring in them. I am certain that many of them have played a worthy part in India's war effort. The School has, of course, been in existence so short a time that most of them cannot have got very far in their careers but I hope that, young as all of them still are, it will not be long before some of them are playing an important part in public life and are helping to shape the new India. I hope that the time will soon come when no Ministry will be considered complete without a representative of India's leading public school on its Front Bench, just as no Ministry in this country, even a Socialist one, can be regarded as complete without representatives of our leading public schools. When that day comes, as I am sure it will, and if Sir Joseph Bhore and I live to see it, we shall feel that our labours have not been in vain.

Lieut.-General Sir THOMAS HUTTON, K.C.I.E., C.B., M.C.: I was rather struck by the statement that there are over 100 names on the list for each term and that not more than a quarter can get in. I am wondering if anybody here has any knowledge as to whether there has been any effort made to create more Doon Schools. There are other fine institutions but I think we all realise that the training of leaders and administrators is going to be one of the great problems of the India of the future. Unless there is some organised training for the Provincial services, which will take the place of the I.C.S., where every effort has been made to get away from the communal point of view, I do not believe India will solve her communal problems for a very long period. If they can catch their administrators young and train all communities together in really high-grade schools and colleges, with a final selection at the end, I think India could build up in time a very fine administrative service. The mere recruitment of young men from Indian

universities by examination will not, I believe, produce what is really required. They will not have that common point of view that is so necessary for the future of India.

I noticed from the paper that a large number of the boys from the Doon School go to Indian universities. We know that some of the universities leave a great deal to be desired in point of discipline, organisation and in some cases, teaching. Do the Doon School boys tend to raise the standard of the universities or do they find the universities demoralising?

Sir HENRY RICHARDSON: May I ask a question which follows on a part of what Sir Frank Noyce said regarding the future of the boys who have left the School? I ask about that because when I was in India, as head of my firm I received a visit from Mr. Foot and I thought he displayed a certain amount of anxiety about placing some of his boys. I have learnt from the lecture that the age is now 11 to 18 and that therefore probably most of the boys go to a university after they leave school. But at that time firms in Calcutta were being hard pressed by the University of Calcutta Appointments Board which had the support of firms belonging to the Chambers of Commerce. It was so successful that the University of Dacca started a similar scheme and then the Government of Bengal started another, so that firms were being assailed all round. When Mr. Foot came as the fourth one I felt very embarrassed about not being able to give him much hope. As a matter of fact, that was the first time I had heard details about this famous School. That may not be my fault and may not perhaps be the Schools' fault, but I do suggest that something might be done to make the School better known to industrial and mercantile offices in Calcutta. With the change of conditions in India those offices will need more and more the type of boy which I believe the Doon School will be able to turn out. Certainly the Calcutta University, if their scheme is still operating, will be able to do much and will probably recommend the Doon boys, but I think that their recommendation should have something else behind it. There is also a St. Paul's School which "Metropolitan" Foss sometimes referred to as the "highest" school in India. It is, literally—it is in the Himalayas! However, it has a very good reputation and may be a serious competitor to the Doon School. I should certainly like to know what line, if any, the Doon School is following on this important question of the future of the boys. Are they all going into the public services or what is being done with regard to placing them elsewhere?

The Rev. R. BURGES: Has any development taken place towards providing a similar school for girls and women?

Mr. JAMSHEED RAHIM: I should like to deal first with the question of the future of the boys. During the war there were about 65 who served in the Army, Navy or Air Force. The oldest boy would have left the School in 1938, which does not give very much time for him to have made a name for himself. So far the majority of boys are still studying and the Doon School lays stress upon the technical side of life. Most of the boys who have gone to England or the U.S.A. are studying science. Some boys have taken up architecture and when they go back to India they will take up jobs for which their qualifications fit them; some will go into business and some are the sons of business magnates who will probably be their own managers.

With regard to the point made about getting the School better known, I think as much is being done as possible and gradually I think St. Paul's School will find a certain amount of competition! So far as a school for girls is concerned we once had a popular debate as to whether there should be co-education in the School and the motion, curiously enough, was defeated. I hear rumours, however, that there is a plan to have a sister school about three miles away. I hope it comes off.

So far as the atmosphere in the Indian universities is concerned, that is a question in which I have been very interested myself, because I had two years in an Indian university after I left school. I would not say I was demoralised, but it made me feel that there was a great deal to be achieved yet in the Indian universities. The life is so much

less regular, whereas in the Doon School practically every minute is chalked out for you and there is very little time in which to idle. Quite often when a boy goes to an Indian university he finds time on his hands and no one to enforce his activities. Some boys do nothing about it although they may be quite talented. There are others who do try to get into the life of the university. I found that most Doon School boys, when they first go into a university, are up against a hostile group who consider that the Doon school boy is a snob. I do not blame this group because, considering Doon School boys have worked and played together for as long as seven years, they naturally tend to come together when they go to another institution. So the general impression is that the Doon School boy does not care for the Indian university. Personally I do not think that that is a correct conclusion. I admit that the boys do flock together, but I do not think it is snobbery at all, and some of the boys have done very well in the social life of the Indian universities. Another point is that the Doon School boy has been playing games since he was 11 and the members of the university who are good at games, but not quite so good (except in the Punjab), are inclined to resent the fact that they should be superseded by these Doon School boys!

THE CHAIRMAN: I think we have had a very interesting and pleasant afternoon, and Mr. Rahim has not only answered nearly all the practical questions put up but has made a very definite contribution of his own to the discussion. I think the fact that he has come here and spoken so clearly and so well to us is one of the factors which will enable us to go away with a high opinion of the Doon School.

I was myself greatly interested in Mr. Foot's paper. It was a practical and instructive paper, and Mr. Foot has made it very clear that he has completely avoided the possible danger of trying to transfer unessential British ideas to India and has accepted absolutely and worked out most carefully the problem of establishing the School on certain ideals of universal validity and as an Indian school in India. That is the only condition on which such a school could continue to exist in the new India now coming to birth. It seems to me that the difficulties and dangers that beset the schoolmaster in a country which has so many deep cleavages in its social organisation have been avoided with great skill and that the School is well on the way to fulfilling the ideal of a school which will turn out boys who will really be citizens of India and not representatives of particular communities or sects.

The question which remains in my mind is whether in this new India the Doon School will continue and flourish. We have to remember that it has taken its origin from British ideas and that at the present time, in spite of much goodwill in this country, the new India is being born in a spirit of very unnecessary (it seems to me) antagonism to British ideas. It may be that those who wish to stimulate the spirit of nationalism find it necessary to erect some antagonist and are putting up in this character the image of the British, but I believe that these ideas are likely to be transient. When the turmoil which is bound to accompany such changes dies down we may find that those ideas and principles and influences which the British have over many years contributed to the building up of India will still remain behind, and that the good we have done in India will not be interred with our bones. I trust that through the initiative of Indians the School will still continue and that its foundations may stand firm in a changing world.

I will conclude by asking you to thank Mr. Foot for giving us such an excellent paper, and Mr. Rahim for reading it with such admirable clarity.

Sir LANCELOT GRAHAM, K.C.S.I., K.C.I.E.: Before we leave I feel sure that we should all like to express our thanks to our Chairman for the way in which he has conducted our affairs this afternoon. Before I sit down having performed that duty I should like to say two things which I should have said if I had taken part in the discussion. The first of these is that I would have expected in any talk about education in India to hear some reference to the great work done in Kashmir by Canon Tindall Biscoe. The C.M.S. schools owe a very great debt to him and he set out to make men of what some people thought was unsatisfactory material. But Canon Biscoe succeeded. If a boy

wants a job in Kashmir it is enough for him to say "I am a 'Biscoe boy' ". I hope that in the course of time it will be enough for any boy anywhere in India to say "I am a Doon School boy".

There has been some reference to the late Mr. S. R. Das. I think I have as much right as anyone here to ask you to pay a tribute of admiration to his memory, for when he was Law Member of the Viceroy's Executive Council and I had the honour of being Secretary of the Department over which he presided, he said to me, " I am not really particularly interested in being Law Member but I am really interested in starting a school on English public school lines. I expect you to do the rest of the work". I will not say that I did, but it is a fact that Mr. Das gave a great deal of time to working out the initial plans and collecting money for the Doon School. After him I should like to pay tribute to Mrs. Das who, in spite of the desperate blow of her husband's death, carried on the preliminary work. We have, of course, a full understanding of the difficulties under which she laboured and I should like to express my gratitude to Sir Joseph Bhore and Sir Frank Noyce for the work which they did. I remember Lord Willingdon coming from the opening ceremony of the school and telling me that he was impressed by the personality of Mr. Foot and thought he would make a good thing out of the school.

I think that we shall all go away from here feeling grateful to a number of people—those who have organised this meeting, Mr. Foot for providing us with an excellent paper, Mr. Jamsheed Rahim for reading the paper with such sympathy and understanding and to our Chairman for steering this meeting so successfully.

The vote of thanks was carried with acclamation, and the meeting then terminated.

FACULTY OF ROYAL DESIGNERS FOR INDUSTRY

The following information on some recent activities of certain members of the Faculty of R.D.I. may be of interest to Fellows.

Mr. GORDON RUSSELL, C.B.E., R.D.I., who, as announced on page 345 of this *Journal*, has been elected Master of the Faculty for 1947–48, is Chairman of the Design Panel of the Board of Trade and Chairman of the Furniture Design Committee of the Ministry of Works. He was appointed to the Distinction of Royal Designer for Industry in 1940.

Dr. CHARLES HOLDEN, F.R.I.B.A., R.D.I., M.T.P.I., has been appointed Architectural Consultant for the redevelopment of the South Bank of the Thames, on the recommendation of the London County Council Town Planning Committee as Town Planning Authority. His task will be to work out a general scheme of development into which the three major projects (Government offices, cultural centre and national theatre) can be fitted, and to exercise overall supervision.

Mr. BRIAN O'RORKE, M.A., F.R.I.B.A., R.D.I., has had the honour of being one of the two architects to be entrusted with the task of designing the new National Theatre, which is to be included in the above scheme for the South Bank.

Miss ANNA ZINKEISEN, R.O.I., R.D.I., is at present engaged on two new murals for the *Queen Mary*. These are each 25 feet long and 8 feet high, with gay and unconventional hunting scenes as their subject. Anna Zinkeisen has recently initiated a scheme whereby advanced students of art schools can obtain facilities for studying pathological and clinical drawing by attending operations at one of the large general hospitals in London. In this she has the co-operation of the Principal of the St. Martin's School of Art, who appreciates the value of this work to the medical profession, for purposes of instruction and record.

Miss ENID MARX, R.D.I., has completed the design for two new moquettes for the seating upholstery of the London Passenger Transport Board's railway coaches. She is working on designs for upholstery for utility furniture, and in collaboration with the Hon. Margaret Lambert has just published a book on *Popular and Traditional Art in England* in Messrs. Collins' " Britain in Pictures " Series.

Mr. E. GORDON CRAIG, R.D.I., attained his 75th birthday in January, and in honour of this occasion the Faculty organised a fund among members and other admirers of his work for the theatre. At present the sum received amounts to £234. Any Fellows of the Society who would care to be identified with this Fund are asked to send their donations to the Deputy Secretary.

GENERAL NOTES

UNITED NATIONS POSTER COMPETITION.—An international competition for the "United Nations Poster of the Year" is announced by the United Nations Department of Public Information, Lake Success, New York. All professional artists and designers are invited to enter and submit poster designs to promote the cause of United Nations throughout the world. It is intended to print and issue the winning entry in many languages for universal distribution.

The competition is being organised in two stages, a national and international. A national Assessment Committee in each State which is a member of the United Nations will forward the three best entries they receive to United Nations Headquarters, where an international committee of assessors will make the final awards. These will be as follows:

First prize	$1,500
Second prize.. ..	$1,000
Third prize	$500

Ten prizes for honourable mention $100 each.

Entries from this country must be submitted to the British Assessment Committee, United Nations Poster Competition, c/o United Nations Information Centre, Russell Square House, Russell Square, London, W.C.1, not later than June 1st, 1947.

The Society has a number of leaflets containing the conditions and a submission form, which can be obtained by Fellows on application to the Secretary.

EXHIBITION OF PAINTINGS BY THE ROYAL INDIA SOCIETY.—An exhibition of paintings, under the auspices of the Royal India Society, was opened on April 23rd by Baroness Ravensdale, a Vice-President of the Society. The paintings are the work of Manjusri Thero of Ceylon, and Sudhin Khastgir, Art Master of the Doon School, Dehra Dun.

Manjusri Thero is a scholar and mystic, who took up painting at the age of thirty-five as a means of expressing the spirit of Buddhism. In the pursuit of this aim he journeyed to Tibet, where he studied under the Chief Artist to the Tashi Lama. During his journey he visited Rabindranath Tagore's International University at Santiniketan, where he studied comparative religion and art. On his return to Ceylon in 1941 he travelled the island in search of old temples, abandoned and hidden in the jungle, to copy their frescoes before they perished. At present he lives some miles from Colombo in a lonely temple, the interior of which has been largely decorated by him. The exhibition at the Imperial Institute consists of twenty of his paintings, along with two sketches of the artist and his temple.

Sudhin Khastgir is Art Master of the Doon School, a paper on which, written by the Headmaster, Mr. A. E. Foot, is published in this number of the *Journal*. His work is essentially Indian in subject and technique, inspired by the life of the common people. Like Manjusri Thero, he studied under Rabindranath Tagore at Santiniketan.

The exhibition will be open on weekdays from 10 a.m. to 5 p.m., till May 7th.

EXHIBITION OF CHINESE CERAMIC FIGURES.—The Oriental Ceramic Society has arranged an exhibition entitled "Two Thousand Years of Chinese Ceramic Figures." This was opened to the public on April 14th, and should be of the greatest interest to students of china and ceramic art. It is made up of Chinese ceramic figures of men, women and animals, ranging in date from the Han dynasty, 206 B.C.—220 A.D., to recent times. The exhibition is open from 10 a.m. to 5 p.m. on weekdays (Saturdays

10 a.m. to 1 p.m.), at 48 Davies Street, W.1, till June 21st. The charge for admission is 2*s*. 6*d*., and for a season ticket 5*s*.

OBITUARY

KING CHRISTIAN X OF DENMARK.—We regret to announce the death, on April 20th, of King Christian X of Denmark.

Prince Christian Charles Frederik Albert Alexander William was born on September 26th, 1870, the eldest son of the then Crown Prince of Denmark, afterwards, King Frederik VIII. The prince attended the Metropolitan School in Copenhagen and proceeded to Copenhagen University, being the first Danish prince to matriculate. On leaving the university he joined the Life Guards as a recruit and made the Army his career. He ascended the throne in 1912 on the death of his father. As king, his daily life was marked by lack of ceremony and by intimacy of contact with his people, in harmony with the democratic traditions and feeling in Denmark. He was a popular monarch, whose presence meant much to the Danish people during the years of the German occupation, from 1940 till the end of the war. On the advice of his ministers, under threat of air bombardment of Danish cities, King Christian allowed the occupation to take place unopposed; and he was allowed to remain on the throne, and was able to see his country again liberated.

King Christian was a keen sportsman; among his interests may be mentioned yachting, in connection with which he was made honorary Chairman of the Royal Danish Yacht Club, and took part in international regattas and events at home. He visited Britain on numerous occasions, both privately and on State occasions.

King Christian was elected an Honorary Royal Fellow of the Society in 1914.

LORD SALISBURY.—We regret to announce the death, on April 4th, of Lord Salisbury, at the age of 85.

The Most Hon. Sir James Edward Hubert Gascoyne-Cecil, K.G., P.C., G.C.V.O., C.B., Marquess of Salisbury in the peerage of Great Britain, Earl of Salisbury, Viscount Cranborne and Baron Cecil in the peerage of England, was born on October 23rd, 1861. Lord Cranborne, as he was until his succession, went to Eton, and to University College, Oxford. In the House of Commons he represented the Darwen Division of Lancashire from 1885 to 1892, and was member for Rochester from 1893 till 1903. For his service during the South African War he was mentioned in despatches and received a Companionship of the Bath. At the end of the war he returned to political life, and in 1900 was made Under-Secretary for Foreign Affairs till his father's death brought him into the House of Lords.

During the war of 1914–18 he again undertook Army service, and in 1917 attained the rank of major-general. In the post-war years he took a prominent part in politics during and after the break-up of the Coalition Government. In the Conservative government of 1922–24 he became Lord President of the Council and Deputy Leader in the Lords; and after the return of Mr. Baldwin's administration in 1924, Lord Privy Seal, and later Leader in the Lords. In these positions he did valuable work on the Committee of Imperial Defence. Reasons of health led him to give up Parliamentary duties, but he served on the Parliamentary Joint Committee on Indian Constitutional Reform which reported in November, 1934. His disagreement with the majority in this Report led him to become Vice-President of the India Defence League, and to oppose the Government's policy in India.

At his seat of Hatfield House, Lord Salisbury's work of preservation and beautifying included the restoration of the Bishop's Palace there, and the setting up of a muniment room for the historic family papers.

Lord Salisbury had been a Fellow of the Royal Society of Arts since 1938.

NOTES ON BOOKS

MURAL PAINTING. By Hans Feibusch. Adam & Charles Black. 1946. 21s.

Architecture, it has been said, is the mother of the arts. Perhaps one should now substitute "was" for "is". For the mural painter, the sculptor, and the craftsman can no longer look to the architect to provide employment and encouragement. The architect has become an engineer and forgotten that he should also be an artist. Functionalism has decreed that plain surfaces have an austere beauty which does not need the painted, carved, or glazed decoration which was the glory of ancient architecture; and the architect himself, however good his intentions, can seldom rely on an enlightened religious or secular body for patronage. Furthermore, the middle twentieth century bids fair to appear to posterity as the period in which architecture disappeared and in spite of enormous technological resources domestic buildings higher than one story or nobler than mass-produced became impossible to achieve. Perhaps when metropolitan man has reversed human evolution and at the behests of atomic strategists become a subterranean animal (as Mr. E. M. Forster and H. G. Wells long ago warned us he might) then in the miles of underground passages, man will again find the value of wall painting. Even then, one fears, the art of exhortation—the poster—will be the only result.

Meanwhile, when will governments, municipalities and industrialists realise the enormous propaganda value of the mural painting—for after all the finest propaganda for the Renaissance church or city state was and is the work of the artists who built and decorated churches, palaces and villas, and thereby perpetuated to posterity and underlined for their contemporaries, the religious principles and social ideals of their time? This ignores the cultural achievement which such a practice also made possible, and without which no civilised society is worthy of the name.

Although this is a factor which Mr. Feibusch does not mention, in what is an excellent book, the psychologist can now add his testimony to the excellent therapuetic and preventive value of "visual material" and the use of "visual aids to protection" (ghastly formula). On the lowest level then, of utility and expediency, much may be said in favour of the all-but-vanished art of mural painting. On a higher level it seems absurd that in a society in which increasing efforts are made to prevent wastage of life and opportunity, that wastage of talent is still permitted on a large scale. For Mr. Feibusch rightly points out that English painters are reaching in their easel pictures a higher standard to-day than for many years. Where are the patrons, industry, church or state, with the vision to see what this means in terms of potential human happiness, efficiency and cultural achievement?

Mr. Feibusch is one of the very small body of artists who have had the good fortune to have walls placed at their disposal by a few enlightened patrons, secular and religious. He has written a modest and intelligent account of his experience, and of the nature and history of his craft. He describes briefly the history of mural painting, and makes a plea for the greater use of the mural painter in all sorts of buildings—including the home. The latter is surely a field in which each one of us may make a small contribution. For a mural may not only be as cheap as a painting in a frame, but can be carried out as an integral part of our furnishings and colour schemes. Here a vista may be opened, there a long wall may be "stopped". What infinite possibilities there are, and how many the competent artists of all æsthetic creeds, capable and willing to carry out such work.

This is a well-produced book, and the illustrations are well chosen. My only complaint is that they are too few, inevitably perhaps when one realises how few living painters have ever had access to a wall. One other point I might make. Mr. Feibusch does not discriminate between the mural painting and the mural decoration. Perhaps the ephemeral is all that the mural painter may hope for these days, but if so this means ephemeral work, in other words the decoration. But the mural painting of the past was generally speaking more than decoration. It was also expression, art of the most serious purpose. Can we not have at least a few buildings designed to last, and cannot we commission a few artists to give of their finest in a technique which is permanent and an intention which is serious? The problems and trials of our age are surely heroic enough material. If Mr. Feibusch's book helps us to realise some such possibility, it will have rendered us all a signal service.

LEONARD GREAVES.

ERRATUM

THE COUNCIL OF VISUAL EDUCATION.—The note in the issue of the *Journal* for April 11th (page 342), on the work of the Council for Visual Education, contained an error with reference to the Council's publications. The four booklets mentioned are priced as follows:

	s.	d.
The Future Citizen and his Surroundings		6
Architecture as a Communal Art		9
Art and Everyman	1	0
Visual Pleasures from Everyday Things		9

These booklets are obtainable from Messrs. Batsford or any bookseller. The Council also publishes leaflets, and these (not the booklets as previously reported) are obtainable at 6*d.* for the set of four, on application to the Secretary of the Council. We regret any inconvenience which may have been caused by this error.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, APRIL 28..Electrical Engineers, Institution of Savoy Place, W.C.2. 5.30 p.m. R. Grierson and Forbes Jackson, "**Domestic Water Heating by Electricity.**"

At the South Wales Institute of Engineers, **Cardiff.** 6 p.m. W. Hyland, "**Some Aspects of Site Insulation Testing, with special reference to E.H.T. Switchgear by Schering Bridge Method.**"

Geographical Society, Royal, S.W.7. 8 p.m. Captain Ejnar Mikkelsen, "**The Eskimos of East Greenland.**"

North East Coast Institution of Engineers and Shipbuilders, in the Mining Institute's Lecture Theatre, **Newcastle-on-Tyne.** 6 p.m, F. H. Todd, "**Some Model and Full Scale Experiments on Side Launching.**"

Victoria Institute, 12 Queen Anne's Gate, S.W.1. 5.15 p.m. Wilson E. Leslie, "**Psychical Research in the Light of Some Recent Developments.**"

TUESDAY, APRIL 29..Anthropological Institute, Royal, 21 Bedford Square, W.C.1. 5.30 p.m. Professor F. E. Zeuner, "**Climate and Early Man in East Africa.**"

East India Association, in the Hall of India, Over-Seas House, S.W.1. 2.30 p.m. P. D. Saggi, "**The Future of Indo-British Relations.**"

Electrical Engineers, Institution of, at the Engineers' Club, **Manchester.** 6 p.m. A. Burke, R. C. Cuffe and W. O'Neill, "**Record of Experience on the Irish Electricity Supply System.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester.** 6.30 p.m. Major S. Pearson, "**Irwell Indiscretions.**"

WEDNESDAY, APRIL 30..Electrical Engineers, Institution of, at the Royal Victoria Station Hotel, **Sheffield.** 6.15 p.m. J. S. Pickles and W. H. Wills, "**Rural Electrification. The Use of the Single-Phase System of Supply.**"

THURSDAY, MAY 1..Aeronautical Society, Royal, at the Institution of Civil Engineers, S.W.1. 6 p.m. W. H. Lindsey, "**The Development of the A.5 Type Gas Turbine.**"

Chadwick Public Lectures, in the Architectural Theatre University College, London. 2.30 p.m. Professor A. E. Richardson, "**Architectural convention and convenience.**"

Chemical Society, Burlington House, W.1. 7.30 p.m. (1) C. W. Scaife, "**Nitration of Olefines.**" (2) A. Lambort, "**Reactions of the nitroparaffins.**" (3) R. L. Heath, "**Addition reactions of nitro olefines.**" (4) G. D. Buckley, "**Formation and reduction of 2- and 3-nitro alkyl cyanides.**"

Town and Country Planning Association, 28 King Street, W.C.2. 1.15 p.m. Clough Williams-Ellis, "**The National Trust.**"

FRIDAY, MAY 2..Chemical Society, in the Washington Singer Laboratories, **Exeter.** 4.30 p.m. Professor M. Stacey, "**Advances in Immunochemistry.**"

Engineers, Junior Institution of, at 39 Victoria Street, S.W.1. 6.30 p.m. Rex Wailes, "**The Post Mill.**"

MONDAY, MAY 5..Chemical Society, at the University, **Birmingham.** M. C. Paine, "**Careers in Chemistry.**"

Electrical Engineers, Institution of, at the James Watt Memorial Institute, **Birmingham.** 6 p.m. H. A. Thomas, "**Industrial Applications of Electronic Techniques.**"

TUESDAY, MAY 6..Chemical Engineers, Institution of, at the Geological Society, W.1. 2.15 p.m. B. A. Southgate, "**The Re-Use of Waste Waters from Industrial Processes.**"

Electrical Engineers, Institution of, at the Engineers Club, **Manchester.** 6 p.m. L. H. A. Carr, "**The Teaching of the Principles of Electrical Machine Design.**"

Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester.** 6.30 p.m. T. W. Corker, "**On Foot through the Peak.**"

Visual Education, Council for, at the Royal Society of Arts. 1.15 p.m. Sir Kenneth Clark, "**The Need for the Appreciation of Design.**" (Buffet Lunch at 12.45 p.m. if Secretary C.V.E., 13 Suffolk Street, S.W.1. is notified beforehand).

WEDNESDAY, MAY 7..Aeronautical Society, Royal, at the Institution of Civil Engineers, S.W.1. 11 a.m.—30 p.m. A full-day Discussion on **Naval Aircraft.**

Civil Engineers, Institution of, at the Engineers' Club, **Manchester.** 6.30 p.m. Discussion on "**The Contract System in Civil Engineering.**"

Electrical Engineers, Institution of, Savoy Place, W.C.2 5.30 p.m R. A. Smith, E. Franklin and F. B. Whiting, "**Accurate Measurement of the Velocity of Radio Waves in the Atmosphere, using Radar Technique.**"

At University College, **Southampton.** T. R. P. Harrison, "**The Development of the Gas-Cushion Cable System for the Highest Voltages.**"

Petroleum, Institute of, at Manson House, 26 Portland Place, W.1. 5.30 p.m. Major Kenneth Gordon, "**The Development of Hydrogenation and Fischer-Tropsch Processes in Germany.**"

THURSDAY, MAY 8..Aeronautical Society, Royal, at the Institution of Civil Engineers, S.W.1. 6 p.m. E. S. Moult, "**The Development of the Goblin Engine.**"

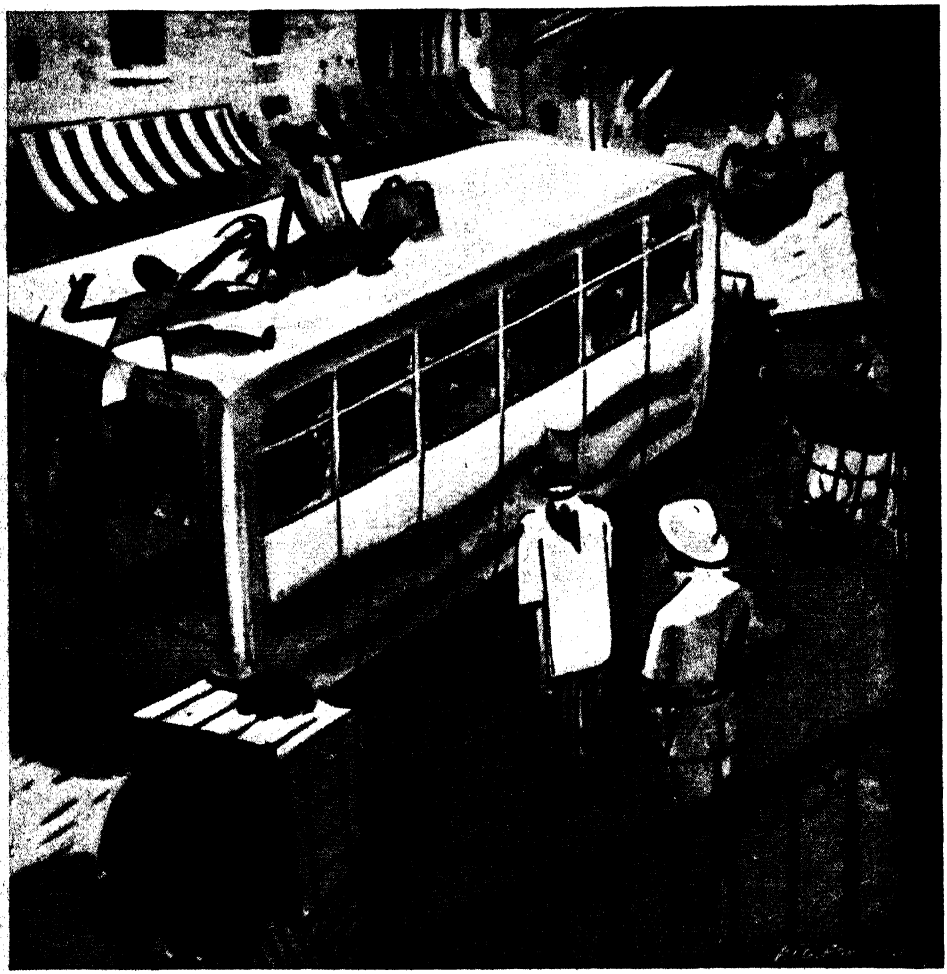
Electrical Engineers, Institution of, Savoy Place, W.C.2 5.30 p.m. C. F. Freeman and H. V. Mather, "**Special Electrical Requirements of a Viscose Rayon Factory.**'

Transport, Institute of, at the Royal Society of Arts, W.C.2. 5.30 p.m. Colonel E. W. Slaughter, "**The co-ordination of road, rail and air services in Hyderabad State, India—experience in the field of British transport vehicles and control of state owned services under one administration.**"

FRIDAY, MAY 9..Chemical Engineering Group, to the Geological Society, W.1. 5.30 p.m. W. A. Damon, "**Experiences of an Alkali Inspector.**"

East India Association, in the Hall of India, Over-Seas League, S.W.1. 2.30 p.m. Sir Walter Gurner, "**Town Planning in India.**"

Engineers, Junior Institution of, at the Institution of Civil Engineers, S.W.1. 6.30 p.m. C. C. Hall, "**The Synthesis of Oil from Coal by the Fischer-Tropsch Process.**"

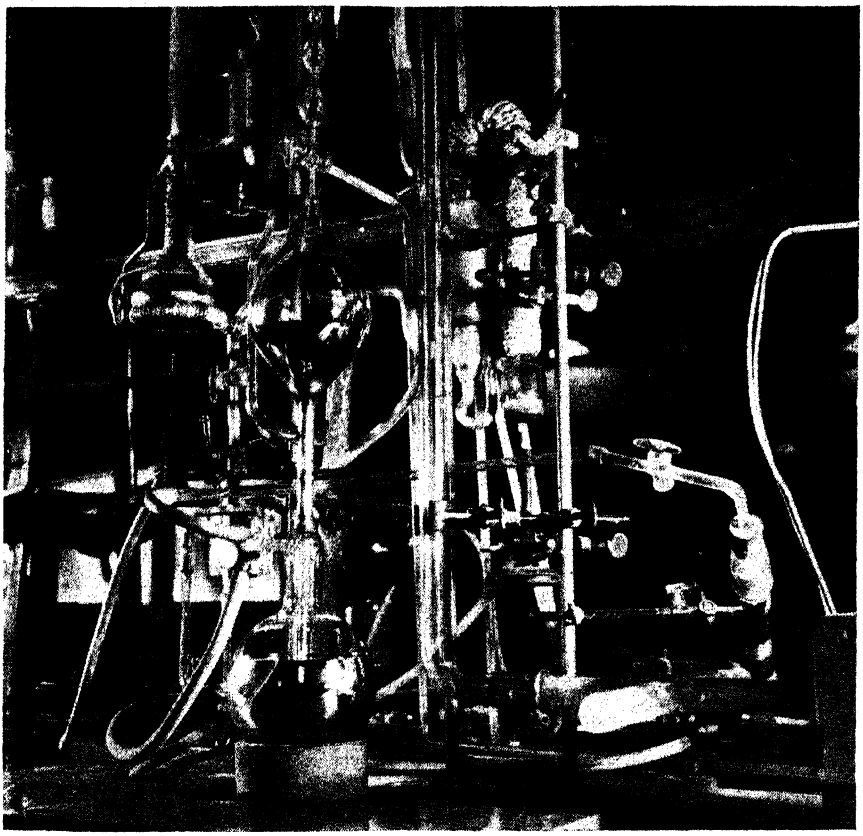


Lobango goes to Town

For years Lobango has run his Gold Coast transport service with a wood and metal bodied bus. Ants ate the woodwork. Rains and floods coated the metalwork with rust. Indigent relatives, riding free on the roof, shaped its surface to their bodies. Passengers and their goats—they both ride to market—played havoc with the fittings inside. But now Lobango really goes to town with a new bus of attractive aluminium alloys—those ant-proof, rust-proof, goat-proof, native-proof metals.

This is just another case where aluminium alloys solve a problem. These strong, light metals are doing a big job in Britain, too. Aluminium colliery equipment lightens the miner's work. Aluminium lined trawler holds are keeping fish fresh on long journeys. In houses, aircraft, factories and offices, aluminium is replacing heavier metals that require extra protection against corrosion. Get facts about aluminium alloys from Northern Aluminium.

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While the Iron is Hot

When iron and steel are made, small quantities of gases such as hydrogen, oxygen and nitrogen find their way into the metal. As they may have far-reaching effects on its properties it is important to be able to find out accurately the quantity of each present. It is only recently that metallurgical chemists have succeeded in finding a means of doing so accurately. One type of apparatus suitable for this purpose is shown above. It is so sensitive that it can detect hydrogen in steel even in such a small proportion as one part in a hundred thousand. Hydrogen can find its way into or out of steel when it is very hot. In the apparatus shown in the illustration the metal under examination is heated to 600° C. while a special kind of pump maintains a vacuum and sucks the hydrogen out of the steel so that it can be measured under standard conditions of pressure and temperature. This piece of equipment is an example not only of the degree of accuracy obtained in analytical chemistry, but also of the way which the chemists and metallurgists of the British chemical industry co-operate to improve the quality of British steel.





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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4742 *FRIDAY, MAY 9th,* 1947 Vol. XCV

CANCELLATION AND POSTPONEMENT OF MEETINGS

It has unfortunately been found necessary to cancel the meeting of the Dominions and Colonies Section arranged for Tuesday, May 20th, at 2.30 p.m., when Mr. Peter Bellew was to have read a paper on "The Development of Australian Art". Mr. Bellew has been called abroad and will be unable to read his paper.

The Selwyn Brinton Lecture, "International Gothic and the Italian Renaissance" by Sir Kenneth Clark, K.C.B., has been postponed till Wednesday, June 11th. There will accordingly be no meeting on Wednesday, May 21st.

MEETINGS OF THE SOCIETY DURING THE NEXT FORTNIGHT

Ordinary Meetings

Wednesday, May 14th, at 5 p.m.—"Economic Reconstruction"—(viii) "Britain's Economic Future". By Alfred C. Bossom, F.R.I.B.A., M.P. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Society, in the Chair.

Cantor Lectures

Mondays, May 12th and 19th, at 5 p.m. (second and third lectures).—"Some Modern Developments in the Application of Photography". By D. A. Spencer, PH.D., D.I.C., HON.F.R.P.S.

Syllabus

The syllabus for this series of lectures was printed in the *Journal* for April 25th. For those interested in the subjects of the lectures, attention is drawn to the Exhibition of Applied Photography, a notice of which will be found on page 405.

THOMAS GRAY MEMORIAL TRUST

In 1946 the Council, under the Thomas Gray Memorial Trust, offered an award of £50 for an invention which was considered to be an advancement of the science and practice of navigation, and an award of £50 for a deed of professional merit on the part of any member of the British Merchant Navy. The Judges appointed by the Society have examined this year's entries for the above, there being for the former Award eleven entries and for the latter one entry. In neither case are the Judges able to recommend an award.

COLOMBO CATHEDRAL COMPETITION

The Dominions and Colonies Committee of the Royal Society of Arts announce

that the Report of the Assessor, Sir Giles Gilbert Scott, O.M., R.A., P-P.R.I.B.A., on the results of the above Competition has been received and the premiums awarded as follows:

First Premium (£500)	Roger A. P. Pinckney, F.R.I.B.A., and Arthur F. E. Gott, L.R.I.B.A., 7, Gray's Inn Square, London, W.C.1.
Second Premium (£200)	F. X. Velarde, B.ARCH., F.R.I.B.A., 3, Abercromby Square, Liverpool.
Third Premium (£100)	J. B. Wride, A.R.I.B.A., 7, Pembroke Terrace, Cardiff.

Details of the time and place selected for the exhibition of designs entered for the competition will be announced shortly.

The Assessor's report is as follows:

"I have carefully examined the drawings sent in for the above competition, and beg to report as follows:

"The number of designs received totalled 59 which, though not as many as might have been expected, is not unsatisfactory, but the average quality of the designs is very disappointing. Many styles are represented, but one gets the impression that most of the authors are out of sympathy with the purpose of the building. The fundamental requirement for the cathedral itself, namely, the religious atmosphere essential in a cathedral church, seems to be generally lacking. Perhaps the tendency of modern thought, being directed towards material values and practical efficiency, with a consequent neglect of spiritual and moral values, has something to do with this. If so, the designing of a Christian cathedral is a direct challenge and confronts the materialist with a bewildering problem, for the proper functioning of a cathedral depends not so much on practical and material efficiency as upon creating a religious atmosphere and a background suitable for, and in keeping with, Christian worship. It is a type of functionalism with which the functionalist is unfamiliar. The building also calls for a quality of calm impressive serenity; indeed this is essential for a cathedral church. Here again, the lack of this quality may be due to the hectic—one might almost say hysterical—times in which we live. It is this lack of feeling for the right character that is so marked in most of the designs submitted in this competition.

"As a result of my examination of the designs, I award the premiums as follows:

First Premium	No. 9
Second Premium	No. 34
Third Premium	No. 38

"The design placed first (No. 9) stands out by itself and is by far the best scheme submitted both in plan and design, and it has a quality and feeling that exempt it from the general criticism previously mentioned. The layout of the various buildings around a great court is excellent and would make not only a most impressive and beautiful group, but allow of a dignified system of covered communications between all the various units. The cathedral, which dominates the whole group, has a quiet simple dignity both inside and out, and interesting contrasts between plain wall

surfaces and architectural features. The cubical content of this scheme is less than that of the designs placed second and third, and it would prove the cheapest of the three. I have no hesitation in awarding this design the First Premium.

"None of the remaining designs were free from serious defects, and it proved difficult to award the Second and Third Premiums.

"Design No. 34, awarded the Second Premium, is more suitable for a mosque than a Christian cathedral, but as an architectural design it has qualities that entitle it to recognition. It has a certain grandeur relying on simple surfaces, both inside and out, that would create an impressive effect. The layout of the various buildings on the site is not very satisfactory, and the subsidiary buildings are not particularly good, but it fails primarily in not being an expression of the Christian religion.

"Design No. 38, awarded the Third Premium, has all the units linked up by colonnades and grouped around two courts. The cathedral, on the north of the larger court, has certain merits; it is not, however, entirely satisfactory either inside or out. The subsidiary buildings are simple and not ineffective. Taken as a whole I consider that this scheme is the best of those remaining after the award of the First and Second Premiums.

"In conclusion, I feel I must express my disappointment at the poor average quality of the 59 designs sent in and, with the exception of No. 9, I am bound to say that I should not be very anxious to see any of them carried out. It is, however, fortunate that the competition has produced one outstanding scheme, which I hope will be carried through to a successful completion".

(Signed) GILES GILBERT SCOTT.

PROGRAMME OF MEETINGS FOR THE 194th SESSION

The Council will proceed in June to arrange the programme for the forthcoming 194th Session, and any suggestions from Fellows, either as to subjects or lectures, will be welcomed by the Secretary.

ECONOMIC RECONSTRUCTION

(V) CRAFTSMANSHIP

By RECO CAPEY, R.D.I.

Fourteenth Ordinary Meeting, Wednesday, March 12th, 1947

Sir HERBERT E. MORGAN, K.B.E., *in the Chair*

THE CHAIRMAN: I have the greatest pleasure in presiding to-day, and in introducing to you Mr. Reco Capey, who is an acknowledged and accepted authority on this most important problem. I think most of us know of his work because he is associated with the great firm of Yardley, who so very rightly and properly use craftsmanship in the furtherance of their business. I think the promotion of sales through craftsmanship, and the production of articles which are made desirable through craftsmanship, is one of the most admirable uses to which the skill of the designer can be put.

Most unfortunately Mr. Capey is suffering from an almost total lack of voice. However, the Secretary has gallantly stepped into the breach, and you will hear Mr. Capey's views and ideas expressed by him.

THE SECRETARY then read the following paper:

Craftsmanship is something of vital importance to us. Yet we are so engrossed with present day problems that we are apt to overlook its significance, and the lessons that can be learned from a study of past achievements. In each age, the men who worked with their hands for the benefit of their fellow beings, had problems that were the direct result of changing conditions. They overcame their problems—we will overcome ours, but only if we assess correctly the changed conditions of our time.

Craftsmanship is fundamental to mankind. It is the term given to work that is well done according to the nature of the material and the purpose from which it is used. A man versed in craftsmanship is skilful, ingenious and dextrous. If he is creative, and we are immediately concerned with that aspect, he is also imaginative. Craftsmanship enters into everything—the running of a home, a town, city or empire. It is good government. Dire circumstances are the result of bad government. They also accrue from bad craftsmanship. Happiness and progress follow good work. In the building up and maintenance of an empire, hundreds of different branches of activity are entailed. We are dealing with one of them – the making of things, good and true making, so that the people of this and other countries may procure objects they desire that possess the maximum amount of perfection and beauty.

From the time when man became a thinking entity and learned to make things for the betterment of his existence, the spirit of progress has prevailed. Prehistoric man carried weapons that would enable him to kill the beasts on which he depended for food. Through observation and experience he learned that his weapons could be improved and made more effective, and, as time went on, he developed more and more weapons and began to make pots and baskets and clothing. He was creating things with the sole purpose of making his life easier. He was learning to be a craftsman. His excursions into the pictorial field were amazing achievements – their beauty lies in simplicity, a simplicity that came through a thorough knowledge of the subject and a superb ability to select essentials. Good craftsmanship is dependent on good selection.

Craftsmanship as we know it was developed in the basin of the Mediterranean. When palæolithic man in Europe was struggling through untold hardships, the result of adverse weather conditions, and because of them was leading a rigorous and not very progressive life, man in Egypt was enjoying sunshine and warmth, and developing rapidly. Freed from the necessity of protecting his body from inclement weather, his mind was able to pay attention to other things. He learned to plant grain and tame animals to help him in his daily labours. By 3,000 B.C., he had developed a system of picture writing and was making things in metal. Craftsmanship was developing according to the conditions of the time.

Egypt developed into a kingdom, ruled over by a Pharoah who owned all the land and considered the people his slaves. Agriculture was the mainstay of the land, but pottery, stone-cutting, weaving and gold-smithing were undergoing development. Building was mainly restricted to the construction of massive tombs that would ensure a safe and enduring resting place for the dead. Time and labour under Pharaonic conditions were of little account, and, in consequence, a colossal amount of manpower was used on monumental buildings. Had we to construct buildings the size of, and in the same technique as, the pyramids and temples we would very quickly

be in the poor-house. But that technique was right for 5,000 years ago. Good craftsmanship is developed with adequate consideration of the conditions of the time. Those conditions might be political, social, economic or climatic. The latter exercised a marked influence in Egypt. Techniques that were rendered extremely effective because of the strong sun would have been impossible in less fortunate climates.

In Asia Minor, in the Valley of the Tigris and Euphrates, things were also developing. The conditions in this Valley were similar to those of the Nile, annual inundations making the soil extremely fertile, so that agriculture was the mainstay of the people. But in material things there was a vast difference between the two countries. Egypt had an excellent supply of stone of all kinds. The Babylonians and Assyrians had none in the south, and very little in the north; in consequence, stone was a very precious material and found use accordingly. But clay was abundant and they made bricks, their architecture being based on the brick unit. Because of the desire for colour, the art of enamelling on brick was developed. It is worthy of note that to-day, after a lapse of 4,000 years or so, the craft of enamelling on brick is almost identical with that practised by the Assyrians.

The Mediterranean basin was the home of the Phœnicians, the greatest trading nation that existed in the ancient world. We can learn much from the way the Phœnicians traded. From their headquarters at Tyre and Sidon they sent out missions and established outposts in all parts of the Mediterranean, one of which, Carthage, became so strong that it outstripped its founders. The Phœnicians set out quite frankly to become marketers of goods produced mainly by other peoples. They carried the wares of Egypt and Asia Minor to all parts of the then known world, and by adventurous sailing went through the Pillars of Hercules into the Atlantic and explored coasts as far afield as Brittany and England. They tested their markets and placed their wares where they were most needed. They discovered that the Assyrians were in need of seals, and established workshops in Syria for their productions. The people of the Mediterranean required pots. The Phœnicians went to Crete and assisted in the development of the Cretan potting industry. They worked in all materials and in all places. They were the first nation of traders and they catered admirably to the requirements of their customers.

There developed a strong rivalry between the Greeks and the Phœnicians. Both nations were traders and colonisers, but the Greeks were slowly striving for a different standard. Their main interest was not in giving other people what they wanted, but in perfecting themselves and so creating an ideal. They achieved it in an admirable manner and the work they produced was of such a high æsthetic and technical perfection, that they rank supreme in the world of created things.

Greece was disciplined. In the search for the ideal every part of every creation, no matter whether it was a figure, a pot, or a building, was refined until the Greek idea of perfection had been achieved. Centuries of experiment, on the principle of trial and error, and selection, a complete understanding of form and of material, produced in the end a national beauty that has not been surpassed.

Greece was in marked contrast with Egypt, a country of plains and desert with invariable sunshine. Greece was mountainous, had a rugged coast and a diversified climate. Her people became traders and colonisers and made contact with the Egyptians, Babylonians and Phœnicians, from whom they borrowed ideas, but

quickly adapted them to their own needs. Greece had an abundance of timber, literally mountains of marble, excellent clay, and she was able to import bronze and ivory. Her craft expression was related to these materials.

And so, with these three historic nations, Egypt, Assyria and Greece, we see that three clearly distinguished types of work were produced, the characteristics of which were determined by the materials available. Egypt had stone, Assyria clay, and Greece marble. The craftsmanship in each case was superb, the inherent qualities of the materials being exploited to the full.

Roman civilisation followed that of Greece, and extended far beyond the confines of Italy. The materials of the entire empire were called into use for the construction of the roads, bridges and aqueducts necessary for the administration of such a vast domain. Rome's contribution to the development of craftsmanship can best be summed up as engineering skill.

The Byzantine Empire began to rival Rome, and in the Fourth Century A.D. Constantinople was rapidly becoming the centre of world culture. Because of her wealth and prestige she attracted craftsmen from all lands, and there was a great development. Design and craftsmanship are largely controlled or influenced by some extraneous force, which may be economic, or social, or political. In the beginnings of the Christian era, the Church began to take the lead. Everything possible was done to portray the spirit of other-worldiness that typified the new faith. Excellent work was done in mosaic, ivory, enamels and textiles.

For a period of 500 years or so, from about 500 to 1,000 A.D., chaos ruled in the West. The foundations of Western civilisation were being formed from an admixture of Roman, Christian and Barbarian. Rome had built cities all over Europe and had connected them by magnificent roads. She had established her customs and culture, but the barbarians who swept into the cities would have none of them. The feudal barons came into existence and protected any who would serve under them against the dangers of the time. But still the Church remained strong. It continued to perfect its organisation, and increased its spiritual and temporal powers, and in time became very wealthy. When the Church became decadent monasteries arose as a protest. The idea of the monastery started in the East, and after being introduced into Italy by St. Benedict in 526 A.D., spread rapidly through Western Europe. A typical monastery had shops for goldsmiths, blacksmiths, scribes, potters and other craftsmen. It was a community complete in itself, capable of supplying its daily needs without communication with the outer world. The monastery became the centre of learning and through the industry of the monks craftsmanship was kept alive. About 1,000 A.D., a new spirit began to arise. The people rose up against the feudal barons, towns began to develop, trade guilds were instituted and commerce grew. Religious enthusiasm was very marked and resulted in a vigorous artistic activity. Universities were founded. The eleventh and twelfth centuries saw the forming of basic elements that ultimately flowered into the Gothic Age, the age of towns and merchant guilds. The Crusades enabled these towns to establish communication with neighbouring countries and the Near East, and they became, in consequence, very wealthy through commercial activity. Those marvels of craftsmanship, the Gothic cathedrals, developed. It was a period of advancement in learning, and life was full of hope and gaiety.

The Renaissance Movement, which began in Italy and reached its zenith there in the fifteenth and sixteenth centuries, spread, in different forms, throughout Europe. Classical culture was revived and the individual cameinto his own. Man's thoughts which, during medieval times, had been concerned with the future life, now considered the delights and beauties of contemporary existence. Every branch of human activity, both mental and physical, was stimulated and the age became one of scientific research and invention. The common man was being educated, and the invention of the printing press enabled books to be printed in quantities. Prior to this invention only manuscripts had been available and their great cost and slowness of production had been a deterrent against the general spread of knowledge. Man's interest in the world and things about him had led to voyages of travel and discovery, such as those of Marco Polo in the thirteenth, and Columbus in the fifteenth centuries. Those voyages helped to increase knowledge and incited men to further endeavours. There was an insatiable curiosity about everything, the earth, the sun, the sky, the air, men, animals and plants. Nothing that concerned the well-being of man was overlooked. Such an outlook caused a certain versatility that was typical of the age, and we need only cite one man, Leonardo da Vinci, to illustrate the general trend. Leonardo was a painter, draughtsman, architect, writer, inventor, scientist, engineer, and many other things. He was a craftsman of the finest order and was concerned with the little as well as the big things of life. His notebooks show that he was as deeply interested in the construction of a simple flower as he was in the problem of a dome for a cathedral. Nothing came amiss to him.

In those days, considerably less than 500 years ago, the craftsman's place in life was as clearly defined as the butcher's, the baker's, or the merchant's. He was not a specialist. A patron would visit his studio to consult him on the building of a palace, the carving of a statue, the painting of an altar piece, the carving and painting of a chest, or the designing of costumes for a church pageant or festival. He was a craftsman with an ever-increasing knowledge of his materials. His work was a matter of civic interest. The people of the time considered that art was a vital part of life. How far we have travelled on the downward path! To-day, the tendency is to consider art as something beyond the usual run of things, and the creative craftsman is regarded, and looks upon himself, as a superior being. He is not. He is just a worker and should be proud of being a worker.

The Renaissance influence in England was great. The vigorous work of the Middle Ages had been done by craftsmen under the stimulus and patronage of the church, but this patronage ceased in the sixteenth century when the monasteries were destroyed. Skilled craftsmen were disbanded and many of them went on the land. The Restoration saw the return of aristocracy and a demand for fine mansions, fine furnishings and portraits. The craft of building had been developed and suitable craftsmen were available, but in other crafts there was a scarcity and they had to be imported from other countries. Gradually we developed a fine school of craftsmanship, and men whose names stand out in history lived and worked here, and exerted a considerable influence on future work.

The eighteenth century saw the beginnings of the revolution that affected not only England, but the whole of the world—the Industrial Revolution. We are feeling its influence to-day. Machines, driven by steam, began to replace hand labour. The

revolution had a vital effect on craftsmanship for it took the creative faculty away from the vast majority of workers who, before its advent, had worked with their hands. Everything was decided for them, they worked with and were controlled by the machine. The idea of craftsmanship, so vital because it was part of life, was sacrificed. Taste declined, and it was not until the second half of the eighteenth century, when Morris came to London and encouraged people to work with their hands for themselves, that things began to improve.

With the beginnings of the Revolution the world was becoming more thickly populated. More and more products for the comfort and convenience of mankind were in demand, and it was appreciated that the old order of things, whereby man created for himself and his nearby neighbours, had to be changed if progress was to be maintained. Merchants of the time commenced the change by grouping hand workers together in factories, supplying them with materials and regimenting the work so that greater production was achieved. This was not a new method, for a similar principle of mass production had been in operation with the scribes in Ptolemy's Library at Alexandria, almost 2,000 years ago.

Science began to take a hand, and through the endeavours of scientists and because of the increased demand from the people, the machine development commenced and life was changed for England, and was soon to change all over the world. From that time there has been a complete change in the methods of craftsmanship from industrial purposes, but little change in handcrafts. Man still works by his hands and creates things with the aid of tools. The only difference between hand production to-day and hand production 2,000 years ago, is that the tools of to-day are more efficient, and for certain purposes, labour saving devices are called in. With industrial craftsmanship the hand in general, is eliminated, the machine being designed and guided to do the hands' work.

The Revolution was a necessary movement because of the increasing population and consequent desire for more goods, and we cannot dispense with its services to-day. Man has been trained to appreciate and expect machine-produced goods, and it would be wrong to deprive him of them. It would also be fatal to machine production were the art of handcraft forgotten, for it is impossible to create successfully without a comprehensive knowledge of materials, not a superficial knowledge, and certainly not book knowledge, but a thorough knowledge gained through intimate association by working with the hand. The poorly designed products that are available to-day are had because their creators had not gained knowledge of their materials by working with their hands on them. Theoretical values are of no use to the creator, practical experience is of untold value. The actual making of an object by the hand gives one an increased power of appreciation of the potentialities of the material. But there has to be something else—the mind of the artist with highly developed sense of selection.

The machine has its advantages, it has its disadvantages, but it is here as an integral part of life, and we have to consider how best to make use of it. We cannot revert to hand production, we do not, if we are sensible, wish to do so, but we must not let hand production drop. In olden days man was a craftsman. Under our present system, with its complexity of machines, he is robbed of the opportunity for actual creative

work. The operative is rapidly degenerating into an unthinking industrial automaton. It would be criminal to allow that state of things to continue.

The Industrial Revolution started with the development of an engine driven by steam, the first one being designed by Thomas Savery in 1689. This was followed by a better one designed by Thomas Newcomen, and first used in a coal-mine near Dudley in 1712. James Watt patented a still more efficient engine in 1769, and in 1782 his rotary engine made steam power available in mills and factories.

The development of industry caused a change in the routine of man's life. When his needs were catered for by himself and power was obtained with the aid of wind and water, he lived in small communities that were practically self-supporting. Luxuries were brought to him by pedlars from other communities and lands. With the new method of factory production, men had to congregate near the factories and new means of transport had to be developed. Canals were the answer and they were of great importance, until railways appeared. The construction of aqueducts, piercing of mountains and general levelling of the route for the canals was a colossal task. It was a major operation in the development of the country.

A further major development occurred in the early nineteenth century when transport was speeded up by means of the railway. Armies of men were employed in building embankments and bridges and boring tunnels, on a scale never before known in the history of man. The industrial development swept through the country and by the middle of the nineteenth century England prided herself on being the most advanced industrial country in the world. The 1851 Exhibition, however, showed her manufacturers that other countries had not been asleep and had just claim to industrial greatness. Many of the works displayed there by foreign competitors were equal to, and in many instances in advance of, the English product. We made extraordinary progress in technical development, but the æsthetic side of craftsmanship in industry was sadly neglected. It was not entirely the manufacturers fault, the artist craftsman was largely to blame—for he had not developed with the times, and had refused to acknowledge the importance of the machine.

Towards the end of the century many men saw the way things were going, and did their best to stop the general trend. William Morris, Ruskin, and others, began to preach against the machine and advocated a return to hand work. Their preaching was of value because it revived interest in work by man's hands, and encouraged artists to turn their attention from the so-called "fine arts" and produce beautiful and practical things. But their work would have been of infinitely greater value had they realised the indisputable fact that the changed conditions of life had rendered the machine a necessity, that the machine had come to stay, and endeavoured, by their great powers, to impart some feeling of beauty to its products. We had to wait many years after their day before real endeavour was made in this direction. But Morris and his followers did appreciate the qualities inherent in materials. They were fine craftsmen and did fine work. We owe them a deep debt to-day, for it was through their activities that the schools began to teach craftsmanship, and the good men we have to-day, and there are many, are the result of their activities.

But we have come to a position where the trends of craftsmanship have to be considered anew, for craftsmanship is not developing with the times. Technically

we are amongst the best workers in the world, but technique is not enough. We have machinery of all kinds that have been so perfected that they do a much more efficient job than did their predecessors of fifty years ago. We have been provided with a galaxy of new materials, which, used properly, will be a boon to mankind. We, as craftsmen, have to see that they are used properly.

England's position, after the most devastating war in history is serious. During the war all our industry was diverted to the manufacture of war products, and creative craftsmanship, such as we are talking about, was almost extinct. It was a great mistake, a short-sighted policy, that prevented the experimental workshops and design studios of all our industries from developing new things for civilian purposes during those vital years. Had they been maintained in an active capacity our task to-day and in the immediate future, would have been much easier. Fortunately we are a nation of craftsmen with craftsmen's instincts. We have a fine heritage from the past, but we cannot go back and trade on our reputation of pre-war days and hope to survive. The war has changed conditions throughout the whole of the world, and we have to adapt our ideas to the new way of thinking. We have to adapt our craftsmanship to fit the times. We must create new products from the new materials and give to those products the qualities we gave to our achievement of the past, and more.

How are we going to do it, and in what way can we obtain the greatest assistance? Firstly, our design and experimental studios must work and develop better design and better techniques than we have ever had before. They must become vital cogs in the wheels of industry and must be accepted as such, for without perfection in design and craftsmanship we will become a hum-drum nation. That is not England's position.

We have a host of schools in this country and they have much work to do. The general tendency is to concentrate on generalities and to ignore the fact that the machine is with us as an integral part of life. There are a few schools that are alive to this fact, but they are too few. Basic training in such crafts as drawing, painting and sculpture, must be given to all students, but after that ground-work each one is an individual problem and it should be emphasised that craftsmanship is the main aim and that work is an essential to success. The schools occupy the proud position of being the training ground for craftsmen of the future. They must not fail in their duty. Students should be given a true assessment of all things relative to their craft, and be knowledgeable on the machine and its activities. They should be given every facility to see the machine in action so that when they design for it they are not wandering in a lost state. They must also be given a thorough training in hand work. The schools must advocate the use of materials, new and old, but they must not fall into the error of encouraging students to believe that hand work is the one and only aim. Hand work is valuable in that it gives a knowledge of materials and their potentialities.

I cannot stress too strongly the necessity for working with our own hands. Many designers in industry to-day are dull and producing poor stuff merely because they do not appreciate materials, not even the ones of immediate concern to them. I would suggest that all employed designers rejuvenate themselves by working in

some way with their hands, otherwise they will degenerate into automatons at the beck and call of the machine.

We must not forget the museums, for they also have important work to do. Both authorities and the general public consider that museums have very little concern with industry. As museums are controlled to-day they are right, because very few of them have any concept of the industrial position. They are filled with all kinds of objects that glorify the past, but it is rare to find one object that glorifies the present. It is right and proper that some objects of historical interest be displayed, but we are living in the twentieth century, not in the past ages. The museum's concern is with the people of to-day, and one of its major duties is to see that there is on display a comprehensive collection of materials used by the hand and by the machine, and to show not merely objects of good taste created in them for contemporary consumption, but also to give some idea of their potentialities. The museums should look to the future and not be advocates of the past.

The schools have the duties of training people who are to design and create for hand work and industry, and give a true assessment of both. The students they produce are the craftsmen of the future, the leaders of the schools are missionaries. The museums present to the man in the street the standard of taste of the day in this and other countries, and help educate him in appreciating the trend of the times. As a nation we dare not take a leisurely attitude where the future of craftsmanship is concerned, and we dare not develop the wrong viewpoint. I can think of nothing more abject to our future development than a remark I heard a craft instructor make quite recently—"There is no place for the machine to-day". It is difficult to conceive the mentality of people who are living day by day with the benefits of machine production about them, yet will not conceive that it is one of the most vital things in our present way of life.

At the present moment the outlook of the world is mainly scientific, mechanistic, and industrial. We have to live with these phases of life dominating everything. As craftsmen we have to carry on our own work, and impart to the machine-produced goods the qualities that make things worth while, so that we may once again come to a position where craftsmanship is considered a vital part of life.

Let us consider the social and economic position of the creative craftsman. Before the nineteenth century there was a constant demand for his productions from kings, nobles, priests and guilds. He was commissioned to do work for a specific purpose. He was part of the social organisation. When this general patronage ceased in the late eighteenth century the new development overlooked the advantages to be gained by using these craftsmen in a true manner, and in consequence, they became ostracised from the system. I believe the craftsmen has to share the blame equally with the manufacturer. To-day we are endeavouring to get back into harness in the right way. The poor taste of the nineteenth century is still with us, but when we consider the advance made in recent years in many things, we know that public taste is by no means dead. The machine is largely responsible for these things and we have to realise that it is not an evil thing until it is allowed to dominate man's mind. With proper guidance it can turn out objects that satisfy æsthetically.

We have seen how craftsmanship has developed in certain ways in different ages because of conditions of the times. We have to see how we can develop to-day. We

want to develop and intend to do so, but with existing conditions it will be a very hard fight. Governing bodies in the past have been aware of the fact that it is necessary to have materials with which to work. We are not so fortunate to-day. Our governing body seems to think that we can work with promises. We are urged to produce more goods for export markets, but very little is done to aid us in obtaining the materials to do it. We are all willing to work, the schools, the museums, manufacturers and craftsmen, but no matter how willing we are we cannot do work satisfactorily with so many restrictions imposed on us by an unsympathetic control. There are instances where government restrictions on the use of material are killing particular craftsmanship. The tendency to-day is to regiment all workers on one level. That is bad for craftsmanship. The worker who does his job better than others should receive encouragement and recognition and adequate recompense.

The government have many duties towards industry, not the least of them being the necessity of encouraging experimental development. Some industries already have their own experimental workshops and are doing good work. The government should see to it, for the sake of the country's future success, that all industries are so equipped.

The basic element of success in this country is trade. To trade successfully we are forced, because of our own lack, to import enormous quantities of raw materials from other countries. To pay for them, and also to obtain the wherewithal to produce other necessities, we have to produce things that are needed. It is no use holding a poll and asking thousands of people what they would like next year. They cannot tell you, because they do not know, but the creative craftsman, the true designer, will be able to lead the way because of his intimate knowledge of materials and trends. He is working, not so much for to-day, as for the future.

So far I have talked about the craftsman working in and knowing his materials. I have just referred to trends—trends are fashions and he has to know them, but if he sits in his workshop and never gets away from it, and there are many in that unfortunate position, he cannot possibly know what is happening in the world. He can obtain a certain amount of information from newspapers, magazines and books, but that is all second-hand, and with such knowledge he will produce second-rate stuff. He must get out into the world and see places. He must study people and analyse their needs according to the conditions they live in. He leads the way, but without knowledge of the world he cannot do it successfully. Travel is the best of educators and any thinking person who dispenses with it is doomed to failure. Things have changed radically since the war. Before the first World War we could afford to send our merchants out into the world to procure luxuries for us. To-day they are limited to the procurement of necessities. To make the things that are exported to pay for them, it is important that our designers should travel and study other people's modes of living.

The standard of living has gone down in this and most countries. That is the inevitable result of war. Our standing with other countries, in the past, was good; we produced more manufactured goods than any other nation. We excelled in technique, but industrialism spread to other countries, and Germany and the United States captured some of the trade we had enjoyed. Our exports began to decline—in the late nineteenth century we produced 30 per cent. of the world's total of

manufactured goods. By 1920, it had dropped to one-third of this total, and at the beginning of the late war it was even lower. That was disastrous. Industry was transferred to war production, and little or no effort was made to experiment in new materials and new techniques for civilian production for six years or so. Some of the materials that were developed for war purposes will undoubtedly find use in industry in the near future, and so will some of the techniques, but only when an economic level of production has been found.

In war-time things are developed regardless of cost. In peace-time cost is a vital factor. The new materials and techniques that were engendered during the war will undoubtedly exert an influence on craftsmanship of the future. Some of these materials were discussed quite recently in this hall, and they are of extreme interest. They have to be used for the good of mankind, and it is the creative craftsman's job to devise ways of using them. He has to be acquainted with all materials and know something of their potentialities. If he is a potter it will help him to know something of plastics and metal. He will be a better creator for pottery if he does.

The war was also disastrous for another reason. We lost markets. Countries that hitherto had been depending upon us for certain things, suddenly found we could not supply them, and so they set to work and learnt to produce for themselves. We have to compensate ourselves by gaining other markets, but it is useless to consider we will do so by resorting to 1939 ideas. We can only do it by developing new things. We, as a manufacturing nation, must lead the way, and we can only do it if our craftsmen do their work properly; the world still wants British goods. Britain depends on her craftsmen—if they do their work well Britain and the rest of the world will be proud of them.

DISCUSSION

THE CHAIRMAN: I am sure you will all agree with me in congratulating the Secretary of the Royal Society of Arts on the very sympathetic way in which he read this admirable paper.

It is my privilege as Chairman to make one or two observations. I myself feel that the work of the craftsman and the ideas of the craftsman need certain protection which is lacking to-day. As a race of traders, there are far too many people who are quite prepared to copy rather than to create. I feel that that is a form of piracy, a form of burglary: quite frankly, I would rather pick a man's pocket than steal his ideas. There is too much of that in the world of craftsmen and in the world of trading, and one would like to see the craftsman's ideas protected, and infringement so punished that that particular offence could be eliminated in the future.

The meeting is now open for discussion, and I hope Mr. Capey has sufficient voice to answer any questions.

Mr. L. J. E. HOOPER: To what countries does the lecturer recommend travel for purposes of study?

Mr. RECO CAPEY: It depends largely on the market for which you intend to cater. If you want to produce stuff for the American market, obviously you must go to America, because without an adequate knowledge of conditions there, you cannot produce satisfactorily for their purposes. It is no use sending English goods to America and saying: "This is what we do in England; you must have it in America, and like it". They will not like it, but only that which is produced for their own needs. I do not mean by that that you have to pander to American taste. You don't. You superimpose your ideas on the American public, at the same time bearing in mind what is good for the American population in regard to their own country.

America is a good country to go to; I think Sweden is another. In my estimation, Sweden is the most advanced country, artistically and industrially, in the world to-day. South America, I believe, is an interesting country, but the people there are inclined to accept what is given to them without expressing any personal desires.

Mr. E. J. CHAPMAN: I should like to say first how much I appreciated the lecturer's remarks, but I do not think he went quite far enough. The cabinet maker and plumber, skilled workers, are real craftsmen. In the old days of trade unionism, a man could not join a trade union as a skilled workman unless he had done seven years' apprenticeship and passed a trade examination. To-day, as long as a man is in the union it does not matter if he is a skilled workman or not. I am a business man in a small way, with many years' experience. You may get a skilled carpenter who has done seven years' apprenticeship and has spent about £200 on tools. To-day, a man joins a union, and he cannot knock a nail in a wall, and the skilled workman has to "carry" the unskilled workman.

In America, and I believe in Russia, they have three grades. The union sees that men pass these grades, and each grade is paid according to ability. Unless we do that, and the trade unions take a proper view, I am afraid this country is doomed. Apprenticeships made this country, but nobody seems to want to be apprenticed to-day. State schools and secondary and technical schools are very good, but a boy must start at the beginning, and the apprenticeship system ought to be revived and encouraged by the trade unions and by the Government.

Mr. RECO CAPEY: I think it is most unfortunate that the apprenticeship system has been dropped to-day, and industry has suffered. I know of one firm who at the moment has a need for about eighty wood carvers on a very large job they have on hand. They cannot find more than five, and the reason is that apprentices in the past ten or fifteen years have not been trained in this particular craft.

It is deplorable that craftsmen to-day are not recognised in industry at their true worth, and that the trade unions insist that any men entering their union shall receive a certain amount of payment, regardless of whether or not they are capable. I said in my paper that as long as all men in unions were considered equal, we were in a pretty bad position. A qualified man should receive adequate recompense: one who is more qualified and more capable than another should receive more recognition. Until we do get back to the position where apprentices are trained in industry we have one thing to develop, and that is the schools. I believe trade unions to-day consider technical schools should be the training ground for the people who go into industry. No matter how well a technical school or school of art trains its students, when the student gets into industry he has to start to learn again, because no school is in a sufficiently strong position to give any student a thorough knowledge of what he is likely to meet in industry. In consequence, I say that all students in schools should have industrial experience, and should be encouraged to visit factories, to see what is happening in machine production.

Mr. FRANK RADCLIFFE: The Ideal Homes Exhibition now on at Olympia provides a useful corollary to this evening's lecture. I visited the exhibition earlier to-day and am finding the impressions made on me very interesting.

Most of the points which the lecturer has made are well underlined there. One sees examples of mass production lacking design. If you go around the exhibition and look for an attractive lamp or lighting arrangement, I think you will be disappointed. If you look for an easy chair, the one you find will not be artistic. In passing, I would go further and say if we went throughout the homes of England, the number of homes with an easy chair on which one can sit for three hours without fatigue would be very small indeed. In cinemas, easy chairs are provided in which it is possible to sit for three hours without discomfort. We are getting design without functional efficiency and functional efficiency without design, and an effort will have to be made to combine both aspects.

I would emphasise one aspect of the lecturer's remarks: that is, whenever we get mass production, artistry tends to disappear. Look at the furniture being developed. It could

be cheap, and yet of good design, provided an artistic brain guided the manufacturing tools. In support of this, I would bring to your attention the fact that many big architectural manufacturing firms are able to make, for liners and hotels and the like, furniture by machinery which is often equal to or better than that made by hand craftsmen. There is no doubt machine-made joints can be made more accurately than any made by hand. The emphasis must now be given to the design side. It is the designer who must be attached to the manufacturing establishment in order to guide the products of the firm. It is from him that the urge for better design will come, and once the design is right the machine can then turn out excellent work. A beginning in this direction can be seen in recent examples of radio and gramophone cabinets at the exhibition. Some have blended design and function to a very high degree, with attractive and pleasing results.

Mr. RICHARD O. PORTER: I should like to endorse the remarks of a previous speaker on trade testing. I do not know if it is a very well known that in the three Services there are a series of trade tests, which grade men in different crafts. Something of that nature could be introduced in civilian life. We should know the value of our tradesmen, in various grades.

THE CHAIRMAN: I think the observations of the speaker who referred to the Ideal Home Exhibition are admirable. There you see the final result of the genius and skill, or otherwise, which has been developed in past years amongst English manufacturers.

Mr. R. COPELAND: As a manufacturer of pottery, I would like to endorse what the lecturer said about artists becoming better acquainted with the materials they are going to use. That is emphasised by our friend's remarks about the Ideal Home Exhibition. If you are well acquainted with the material you are working in, and trying to design, the results are very much more effective.

Mr. KEITH COLEBORN: The lecture has covered fully the economic aspect of craftsmanship. I suggest that equally important is its social significance. There is in craftsmanship the factor of the joy of making something. Many of the questions which have been raised, whether or not an article is better if made by machine or made by hand, are questions which can be argued, but there is no argument about a man being better for being able to produce something by his own hand. Craftsmanship has a social value, which should not be overlooked.

THE CHAIRMAN: Before the lecturer sums up, and makes his observations on questions asked, I myself am rather intrigued about this proposed use of museums. I am not sure whether I gathered correctly that he would like us to see there objects of utility for present-day use. My own view is that that is admirable in itself, that one should be able to see them in places available in which they may be seen, but I should think that a museum is definitely for the specific purpose of showing the creations of past ages, and not of the modern age at all.

Mr. RECO CAPEY: The question of the craftsman knowing his material and the designer of pottery knowing his material—he should know it, but knowing his material, which is clay, is not enough. He must know metal ; he must know cloth. He must know other materials besides clay or he will be a bad potter, and will not produce good work for you. It is only by a comprehensive knowledge of a galaxy of materials that you are capable of appreciating the potentialities of the one you are mainly concerned with.

As for the social aspect, the joy of making a thing, I believe every man is fundamentally a craftsman. Every woman working in her home, and taking a joy in making her home beautiful, is fundamentally a craftsman. Every business man who takes a pride in his business and in making it a success, is fundamentally a craftsman. Every little schoolboy who gets a penknife and whittles about on a piece of wood, is making something, and that is one of the greatest joys of life.

I think you will remember that all through my talk I stressed the necessity of making

things, of working with your own hands, and every designer, every creator, every craftsman, no matter whether he is doing individual things or things for mass production, must of necessity work with his hands, otherwise he cannot know his materials, and cannot also know the joy of life. It is only by producing things yourself that you really will enjoy things. The housewife who is a cook, and cooks a wonderful dinner, has a joy in it. The plumber who does a job of work well has a joy in it. Anyone who makes anything is really participating in the joy of life. That is what happened in the Middle Ages, when people were fundamentally craftsmen. I said life in those days was full of hope and gaiety. The man who is making things appreciates and knows hope and gaiety.

As to museums, I dislike the idea intensely that a museum is fundamentally a place for staging epics of the past. That is the general conception of a museum. Must museum authorities pander to it? The museum is an educational institution, and we are not being educated if the concern is merely with past productions. I want to see beautiful modern productions. I do not want to see in a museum a thousand books that were produced from the thirteenth to the sixteenth centuries and to be told they are good because they are in a museum. I want to see fifty books of that period, but along with them I want to see fifty books produced to-day by leading craftsmen of to-day, and another fifty produced by the machine to-day, so that we have a comparison. I want to see pots from China, from Persia, Mexico, and all over the world of past ages in the museums, but side by side with them I want to see the best productions in pottery of to-day, not merely hand productions, but machine productions.

I say that the machine can satisfy æsthetically. I firmly believe that, and if a thing can satisfy æsthetically then the product of that thing should be in a museum. The museums have a job of work to do, of showing the public past achievements, and also present-day achievements, and furthermore, to give some guidance as to what might happen in the future. I believe the museum has one of the most important jobs of work in the future development of this or any other country. It has to show people what has been done in the past; it has to show people what is being done to-day; it also has to show people something of what might be produced in the future, and that is the most difficult task of the whole lot.

THE SECRETARY: In connection with what Mr. Capey has been saying about museums, it may be of interest to mention that this room in which we are sitting was originally designed, when this building was put up by the Adam Brothers in the eighteenth century, to be an Exhibition Room, particularly for new designs of agricultural implements. It was a permanent collection, and in that sense it constituted a museum, but it was intended to serve contemporary practical requirements by spreading the knowledge of new developments, and this room therefore, played a very important part, in the revolution which came over the agricultural industry in the latter half of the eighteenth century.

As time wore on, these ploughs, drills, reaping machines, etc., which, when they were first brought here, were new, became merely of historical interest, and they were then distributed to various museums, round about the year 1850.

THE CHAIRMAN: I am sure you will all join with me in congratulating Mr. Capey on his really intriguing paper. There are many problems there that some of us could discuss all night, but the meeting usually closes at about this time, and so it only remains for me to propose a most hearty vote of thanks to Mr. Capey. Will you please express that in the manner usual amongst English men and English women?

Mr. GORDON RUSSELL, C.B.E., R.D.I.: May I, on your behalf, thank Sir Herbert Morgan for taking the Chair?

I think he has done a service in calling attention to our standards of craftsmanship. In America, the tendency is that unless a thing is mechanised, it does not get done; if you have a few apples in an orchard, you have to let them lie on the ground because there is nobody to pick them up. They seem to be losing the sense of working with

their hands. As to the relation between craftsmen working with their own hands and design in industry, a lot of people think you can go over to mass production and make everything in that way. Unless you have the complementary workmanship of the individual, you will not get any high standard of mass production. A good example to take is the late Eric Gill, who was a great craftsman, a fine letter-cutter, carver and sculptor. He also designed several founts of type for the Monotype Corporation, and the result in printing was extraordinarily stimulating.

The vote of thanks was carried with acclamation, and the meeting then terminated.

THE WORK OF THE RHODES TRUST

By the Right Hon. LORD ELTON, *Secretary, Rhodes Trust*

Dominions and Colonies Section, December 17th, 1946

The Right Hon. VISCOUNT BENNETT, K.C., P.C., LL.D., *President of the Society, in the Chair*

THE CHAIRMAN: We are privileged to-day to have as our speaker one of our most distinguished scholars, and the author of the best book on the British Commonwealth yet published. I recommend all of you who desire to have a knowledge of the ramifications and complexities of the Commonwealth to read that volume. I have been telling Lord Elton that we should have a cheaper edition of it, but of course in these days of shortage of paper and high wages it is difficult to get books at the price we should like.

He is going to speak to us to-day about a subject which I know will be deeply interesting to you all. The work of Cecil Rhodes represents the realisation of the vision of one of the very greatest men of modern times. It is not every man who has the vision to see what Rhodes saw in Africa.

I recalled when I climbed to the top of the hill where he is buried, seeing the grave of Rhodes, and, not far away, that of Jamieson, that these men had vision. There are many men of great brains, but the world produces a limited number of men with vision, and that Rhodes had great vision is now recognised by everyone.

What he did in his will is something about which Lord Elton will speak: the broad basis of his gifts under the Trust has inspired the admiration of every thoughtful man who is interested in an educated democracy. We are suffering from a lack of an educated democracy. We easily prattle the language of democracy, but it is a different thing altogether to see it in operation as it should be. I remember once a very distinguished member of the Canadian Parliament finding a supporter because she thought his hair was the finest head of hair she had ever seen on any man; that so commended him to her that she voted for him. That is democracy at its—well—average level. It sometimes is a high average. If you live in some of the sections of America, and are present at the polling station where new settlers who have recently become naturalised are enabled, with high intelligence and great knowledge, to exercise their franchise as it is represented to them by those who control them, you would understand something of what our friends in India are striving for and will probably attain.

Lord Elton will explain to us to-day, not only the workings of the Rhodes Trust from the educational standpoint, but some of the great contributions it is making from time to time to support movements throughout the British Empire that are playing a not unimportant part in our development. The presence of one gentleman in the audience this afternoon, whose name I will leave you to guess, is because of the assistance given by the Rhodes Trust to a great Society of which he is the distinguished treasurer. I tell him we are very glad he came for the reason he alleges, because it gives him an opportunity to hear a very distinguished lecturer, and he says he will thus kill two birds with one stone.

I think it would be out of place for me to discuss in any detail matters connected

with the Rhodes Trust. The duties of a Chairman were explained by a great American as standing up, speaking up, and shutting up. I have already discharged two of these: I think perhaps the third qualification is about to happen, but before doing so, I do commend to you the speaker of the day, not only as a great scholar, but as one who is giving of his very best for the youth movement throughout the world, and an author of great distinction. His vigorous English sometimes finds a place in one of the oldest of our newspapers, and I think perhaps within living memory you will find some evidence of his ability to express his views upon many subjects.

Therefore it is with great pleasure and satisfaction that I present to you Lord Elton, who will speak to us on "The Work of the Rhodes Trust"

LORD ELTON then gave the following address:

I must thank you, Lord Bennett, very much for your very kind words, and for your presence here this afternoon, and, not least, for the admirable free advertisement of one of my works!

Although, Ladies and Gentlemen, I am a responsible official of the Rhodes Trust, I shall do my best to give you some idea of its origin and functions without, I hope, too vividly recalling the headmaster's annual speech day report, which is usually saturated in what in anyone else would be called complacency, though in a headmaster it is perhaps best described as sober satisfaction.

All the activities of the Rhodes Trust—and as the Chairman has already hinted, they are considerably more varied than is commonly known—are of course ultimately based upon the Founder's will, which was the first example of the dedication to public purposes of one of those great fortunes which the industrial revolution had made possible. In that, as in many other respects, the example set by Mr. Rhodes has been so widely followed that it is very easy for us to-day, familiar as we are with a number of copyists, to forget that the course the original took was unprecedented. The Founder was, of course, a man of highly-developed imaginative powers: that is evident from the whole of his career, and from many a little touch that will be familiar to those of you who have read his biographies. You may recall, for example, how he insisted that the bridge over the Zambesi should be built so close to the Victoria Falls that the spray should always fall on the carriages of the trains as they crossed the river. Or again, as Lord Bennett has just recalled, you remember how he selected for himself and for those who had deserved well of their country that lonely mountain site among the Matappos, as a last resting-place.

So it is not to be wondered at that he should have left behind him what is, I suppose, the most imaginative last will and testament on record, all the more so since the will which founded the famous scholarships is the last of a series of no less than seven wills which he had profoundly meditated over a period of not less than twenty-two years—from 1877, when he was twenty-four, until 1899, when he was forty-six. The first, which he sketched when he was only twenty-four, and had not yet built up his fortune, purported to leave the fortune which he had not yet accumulated to the foundation of a secret society on the model of the Jesuits, whose purpose should be the advancement and extension of the British Empire. It was the last will, the will of 1899, drawn up when he was forty-six, which founded the scholarships by which he will always be remembered. It was that will which contained the key phrase, of which Rhodes wrote in a letter to a friend that "the thought

came to me from the sea", which must always be in the mind of those who are responsible for administering his will. It is a phrase in which he described the sort of man whom he wished chosen for his scholars. He wanted, he said, "those who have shown during school days that they have instincts to lead and take an interest in their school mates, which attributes will be likely in after life to guide them to esteem the performance of public duties as their highest aim".

That is perhaps not very elaborately chiselled English—Rhodes was never a stylist—but he did continually rough hew great and fertile ideas; and this, as the experience of the scholarships shows, is most certainly one of them.

Now what was his object in founding the scholarships? It was certainly the same as he had set before himself in that early phase when he dreamed of a great world-wide secret society on the model of the Jesuits or Masons. He had two great objects, but his primary object was undoubtedly still to further the interests of the British Empire.

Incidentally, we should always remember that it was Rhodes' profound conviction —and your lecturer is the last person to dissent from him—that the power and influence and cohesion of the British Empire is our greatest possible, our one great possible, contribution to the stability and progress of world civilisation itself. What Rhodes wrote there was: "I contend that we are the finest race in the world and that the more of the world we inhabit the better it is for the human race". There again, that is very frankly, perhaps crudely, put. Again, your present lecturer, though he might discreetly use other phraseology, would be the last person to dissent from that sentiment, which in modern terms may perhaps be expressed as meaning that the world at the present moment stands in urgent need of nothing more than the characteristic Anglo-Saxon ideals of liberty and justice and toleration.

The second great idea which Rhodes linked with the prosperity of the British Empire was the closest possible association between the British Empire and the United States of America. So urgent did he believe that need to be, that he made it clear that he was perfectly prepared, if necessary, to see that association under the American flag. What mattered to him most was the cohesion, the most intimate cohesion possible, between the two great branches of the Anglo-Saxon race.

Well, that is the basis of the will, and one has only to add that at the last moment he added what was a not very logical extension of the main idea, the extension of the system to Germany in the form of five scholarships. That provision has had various vicissitudes since. Rhodes had had an interview with the German Emperor, by whom he was considerably impressed. He was pleased that the learning of English had just been made compulsory in German schools, and I think we must suppose he sensed the power and ambition of Germany and believed, and said in print, that if a permanent friendship between Germany and the Anglo-Saxon race in its two branches could be ensured, then the peace of the world was ensured in perpetuity. And who shall say he was wrong?

So he left his fortune of over three million pounds to five Trustees in the first place, of whom the best known were Lord Rosebery, Lord Grey, and Sir Alfred Beit, and in the famous final draft of his will laid down with a remarkable degree of detail his wishes for the establishment of his scholarships. His long-meditated conception of the Rhodes scholarship system contained at least three epoch-making

and unprecedented ideas. One was the primary emphasis which he laid on character, as combined with and yet distinct from intelligence. Another was its corollary, the absence of any written examination in the selection of his scholars. Yet another was the fact that the whole purpose of this Foundation was to do what had scarcely been done before, to bring young men, not to universities in their own countries, but to bring them out of their own countries, often across the breadth of the whole globe, to an ancient university in the metropolis of the British Commonwealth. In particularising his wishes with regard to the character of his scholars, he said that attention must be paid not only to literary and scholastic attainments, but also to character and the social qualities. He proceeded to devise a rather elaborate system of percentages as a suggestion to those who should eventually have the awarding of the scholarships. That system has never proved in practice very workable, and the wishes of the Founder, as laid down at length in the will, can best perhaps be summarised by saying that the Trustees to-day interpret them as meaning that a Rhodes Scholar must have some definite quality of distinction. He must either have first-class intellect founded upon sound character, or else quite exceptional character upon the basis of sound intellect. In other words, neither the ape-like he-man nor the spineless bookworm will suffice. You need the all-round man with high intelligence combined with exceptional character. At one time or another, selection committees, of whose work I will speak in a moment, have no doubt, being only human, leaned sometimes to one side and sometimes to the other, but on the whole I think it may be said they have been astonishingly successful in fulfilling the Founder's wishes. It was alleged, in the early days of the Rhodes Scholarships, I am told, that perhaps an undue proportion of Tarzan-like athletes, apt to walk about with the backs of their hands resting on the ground, was selected. That is not so now. The mere athlete is by no means equipped with an automatic passport to a Rhodes Scholarship. If there have been errors in the past twenty years, and there have not been many, I think probably the boot has been on the other foot. Occasionally the pure intellect has perhaps been given too much preference at the expense of other qualities, but on the whole I think the record of the selection committees, as evidenced by the record of the Scholars themselves, has been most remarkably successful.

The first impact of the Rhodes Foundation, both in America and in Oxford, was of course immediate and startling, and it provoked a cloud of suspicion on both sides of the Atlantic. The dovecotes of Oxford were fluttered at the expectation of what was called the American and Colonial invasion, likely to disturb the peace, and the Oxford accents, of the ancient quadrangles. And in the United States, where Oxford had long been looked down on as something of a backwater, doubts were expressed as to whether Rhodes Scholars would get much by abandoning what was then the national tradition of going, if you went at all to an overseas university, to Germany, and having recourse to the celebrated but presumably old-fashioned university of Oxford.

They went to Oxford, and found there standards of thoroughness, in study and methods of teaching and examination, which were wholly new to them and which soon commanded their deepest respect. So much so, that one of the more interesting side consequences of the Rhodes Scholarships has been that in a number of

American universities the Oxford tutorial and college systems and the Oxford methods of examination have been extensively imitated, and have exercised a very salutary influence throughout the university world of the United States—partly, though not wholly, due to the ability and enthusiasm of the secretary of the American Rhodes Scholarships, Dr. Frank Aydelotte, now Principal of the Institute of Advanced Research at Princeton.

As to methods of selection, as practised by the original trustees and their successors: briefly, in every constituency where there is a selection to be made, there is an unpaid selection committee with its secretary, and in the larger countries where there are a number of provincial elections to be made (as pre-eminently in the United States of America, which elects thirty-two every year), there is a general secretary. I think it may be said that in the greater constituencies—in the United States, in Canada, and in South Africa—the Rhodes trustees are fortunate in being served by representatives just about as able and well chosen as could possibly be expected.

As to the selection committees themselves, the trustees have never laid down any hard-and-fast regulations. The general custom varies slightly from country to country, according to the number of old Rhodes Scholars available as members of the committees, for it is generally found that a considerable leaven of former Rhodes Scholars makes for the best selection committee. In the U.S.A. 100 per cent. of all the selection committees, excepting only the chairman, is composed of Rhodes Scholars. In the other constituencies the normal form is that a committee contains three or four former Rhodes Scholars and three or four men prominent in the administrative or business life of the community. They, of course, have an extremely difficult and exacting task to perform. You have to remember that there are to be elected every year in normal times approximately thirty-two from the United States and thirty-four from the Dominions and Colonies. I was talking to a very distinguished member of this Society just before we came on to the platform, and was surprised to find that he did not know there were Rhodes Scholarships for the Colonies: in addition to the Scholars from the United States and the five great Dominions, Scholars come from Rhodesia, Newfoundland, East Africa, Bermuda, Jamaica, and Malta.

In 1916 the trustees obtained power from Parliament to revoke the codicil and abolish the German Rhodes Scholarships, and thereafter they increased the scholarships allotted to the United States and the Dominions, in order to meet changes of population in certain parts of the United States and the Empire. In 1929, when a new Act was passed giving the Trustees power at their discretion to found new scholarships, two German Rhodes Scholarships were revived. These lapsed in 1940, and in the following year two scholarships were created for India. They were to come into force after the war, and the first election in India has just taken place. I received an account of it by air mail yesterday morning.

That means that to-day, in a normal year—there are no normal years at present because we are making up leeway for the suspension of scholarships during the war—there will be approximately thirty-two scholars from the United States and thirty-four from the Dominions and Colonies.

It is clearly a very difficult task to select a born leader of his generation somewhere

between the years of nineteen and twenty-five, on the basis of an interview, combined with a certain amount of knowledge of his past career. The selection is based on a written statement by the candidate (often highly symptomatic), on confidential testimonials, his academic record, and, above all, a personal interview, as to which the selection committees by now have built up something like a highly-specialised technique. I think they could probably give points to most of the Oxford colleges in the art of interviewing a would-be scholar. The Rhodes Scholar is slightly older than the average undergraduate, and has approximately two years of university residence behind him. That makes it a bit easier to pick him without a written examination than it would be if you had to choose him at nineteen. You have considerable academic evidence to go on. Although a few experiments were made here and there by selection committees in asking their candidates to write an essay, these have all been abandoned, and the examination rests on the basis just described.

When the man is selected, his dossier is sent to Oxford, where Dr. C. K. Allen, the Warden of Rhodes House, who is responsible for the Rhodes Scholars in Oxford, has the at present very difficult task of finding the Scholar entrance to one of the colleges, preferably one of those colleges for which he has opted. He is invited to write the names of eight colleges in order of preference, and if possible admission is obtained for him to one or other of those choices.

That is the framework of the administration of the Rhodes Trust, except that there remains the general secretary, who is at present myself, whose responsibility is for the organisation of the scholarship system as a whole, for the finances, and indeed for everything, since any matter which comes before the Trustees, even if it concerns some matter of discipline or administration in Oxford directly affecting the Scholars themselves, ultimately must go to the Trustees through the general secretary.

What have been the results of this method of selection? It is not altogether possible to arrive at a fair estimate on a purely statistical basis. For one thing, during the early years of the American and Dominion Rhodes Scholarships, the Scholars were very much handicapped by the survival of the requirement of compulsory Greek at Oxford. Very few American and Dominion students had studied Greek at all; consequently the competition was severely narrowed by that requirement, which survived up till just after the first world war. Then there was the handicap that the method of electing the American Rhodes Scholars was not wholly satisfactorily adjusted until midway between the two world wars. Rhodes left two scholarships to each of the States in his will, and the original system which gave each State a chance of electing two years out of three meant that the under-populated States used to elect Scholars of a markedly lower quality than the great and populous centres of American life. It was not until a new system was adopted which provides for election by groups of States, that the American Scholars really came academically into their own.

Those two factors militate against the accuracy of any statistical survey. There is also the further factor that so many, and indeed an increasing number of, Rhodes Scholars devote themselves not so much to reading the ordinary Honours Schools, in which First Classes and Seconds, Thirds and Fourths are awarded, as to some form of post-graduate research which leads to a degree, but not to a class. So that

when you say a certain percentage has obtained Firsts, you have to remember those limiting factors. You have further to remember that if you take an over-all percentage of all the Rhodes Scholars you include such small constituencies as Bermuda, Malta, and even East Africa, which can hardly be expected to produce first-class academic material as yet.

If you compare English First-Class Open Scholars and Exhibitioners, who have obtained First Classes between 1903 and 1937, you find that of the English Open Scholars (who, after all, are experts in the art of passing English examinations), some 27·9 per cent. obtained First Classes; whereas if you take the percentage over the whole period you get 16·5 per cent. of Rhodes Scholars obtaining Firsts. If you take Firsts and Seconds together, you get 76 per cent. of English Scholars and Exhibitioners as against 69 per cent. of Rhodes Scholars. If you take the percentages among individual Rhodes Scholars by constituencies, you get surprising results: New Zealand has produced 26·3 per cent. against the English 27 per cent. Australia 32·1 per cent. against the English 27 per cent. Statistical evidence points to an increasingly satisfactory standard on purely academic grounds.

Up to 1940, 521 Blues had been awarded to Rhodes Scholars: a number of them obtained three or four Blues. That is pretty satisfactory, seeing that a number of the games played are not familiar to Americans, or indeed to some of the men from the Dominions.

An even more searching test is the after career. There we find that the largest single categories of men have taken up some form of education, and I do not think the Founder would have been displeased at that. He said educational relations make the strongest tie. Six hundred to 650 men out of the 2,196 who obtained scholarships up to 1940 have entered some area of the educational field, and among them you have Kingsley Fairbridge, who died young, but not before he founded the Fairbridge Farm Schools which have made so great a contribution to emigration.

You have twenty presidents of universities or colleges; at Harvard seven Rhodes Scholars are professors, four other professors, eight tutors; at Oxford one head, four professors, eight fellows. In Law, there are nineteen judges, twenty K.C.'s, and a number of distinguished lawyers in the United States, where the same insignia, of K.C. and the rest, are not in use. In Medicine, over 150, who include the two leading brain specialists to-day in England, the first health officer of the Union of South Africa, and Sir Howard Florey, who developed the use of penicillin. In non-academic sciences, Dr. Hubble, the Mount Wilson astronomer, and four fellows of the Royal Society. In business, the general manager of the British South Africa Company; the President of the National Trust Company of Canada; the president of the Chesapeake & Ohio Railway. In the Church, Rhodes Scholars include an archbishop, a bishop, and a quite considerable group of missionaries in China. Writers include Elmer Davis, Christopher Morley, and Clarence Streit, the author of *Union Now*.

There are more than 100 Rhodes Scholars in the Civil Service, including the Governor of Northern Rhodesia, the Chief Forestry Commissioner in England, the Chief of the Far Eastern Department of the Department of State in the U.S.A., and twelve members of the Canadian war administrations.

Politicians include Jan Hofmeyr, Field-Marshal Smuts's brilliant lieutenant and

right-hand man; Norman Rogers, Minister of Defence in Canada, whose premature death cut short a brilliant career; a number of provincial prime ministers in Canada, and three members, at the moment, of the U.S. Congress.

That is only a very partial and limited survey of an exceptional minority, though I hope it is sufficient to show that there is a satisfactory number of distinguished persons amongst former Rhodes Scholars. The Founder would have been the last person to suppose that his ideal of rendering public service was necessarily best discharged by those most in the public eye. It may well be that some schoolmaster or parson or doctor, never heard of outside his own neighbourhood, may be rendering far more valuable public service than a dictator or a field-marshal. Those best acquainted with the records of the Rhodes Scholars would agree that both in the careers of those who have made names for themselves and in the general average of service rendered, they have amply lived up to their Founder's ideal and have rendered in very varied ways highly valuable public service to the community.

In that connection it is worth noting the record of the German Rhodes Scholars. If you take the election after the revival of the Scholarships in 1929: during the following ten years nineteen came into residence in Oxford. Of that nineteen, eight managed to get outside Germany altogether and in one way or another served against Germany during the war, several of them obtaining military decorations for bravery in the U.S. Army. Of the remaining eleven, at least four are known to have conspired against the Nazi regime, and at least three are known to have been executed by it. There may have been more, but facts are not yet fully available. However, one may feel now with regard to that record that Oxford there too had its effect.

One interesting effect of the scholarships has been its influence on British educational practice. After all, it is strange when you reflect on it that before the Rhodes Scholarships were founded there was no scholarship system which set out to take account of character as well as intellect, and yet experience shows us that all great achievement requires not only intellect but character. It is strange, therefore, that we have consistently selected the climbers upon the ladder of educational opportunity by means purely of a written intelligence test. I remember in my own College at Oxford, when I first became a Fellow, how very much opposed the old Head of the College was to any form of personal interview. Although subsequently the tradition of the personal interview was established, I can only remember perhaps three occasions in the twenty years I was a Fellow, when the personal impression produced by the candidate was definitely allowed to outweigh the testimony of his written work. Those three young men, I should myself say, are three of the four most distinguished old members of the College of that period, so there certainly the method was justified.

It is strange that the Rhodes example was not earlier followed, for anyone who has taught in a university knows there is a small but constant percentage of men who are the inevitable laureates of any examination room, who walk away with their First, but whom you would not trust to run a whelk stall effectively for a week. It is strange that we should have confined our selection of the potential leaders of the future within such narrow limits.

But it is interesting to note that the example of the Rhodes system is beginning at

last to spread, particularly in the United States. In 1922, Swarthmore, of which Dr. Frank Aydelotte, our indefatigable secretary over there, was President, introduced the novelty of scholarships without written examination, followed by Harvard with its so-called National Scholarships. And I am told that the record of these scholars at both places compares very favourably, not only on social but academic grounds, with those chosen by the more conventional methods.

We find even in England now a tendency towards replacing the purely written certificate examination with a wider test, which shall include some account of the candidate's character as evidenced by his school record. I have no doubt that there too the example of the Rhodes Scholarships has had a considerable influence.

How far have the scholarships fulfilled the main objects of the Founder—the unity, prosperity and cohesion of the British Empire and close understanding between it and the United States, and beyond that, the peace of the world?

Of course, it was a great imaginative stroke of Cecil Rhodes's, that he should simply have provided for these young men coming to Oxford and being turned loose there to do and learn what they pleased, with no propaganda. No one says "you ought to think this or that". Rhodes believed so passionately in England and Oxford and education that he thought he could do no better than turn these men loose in Oxford, and that is what happens. Every now and then, one in every four or five hundred, perhaps, may turn into an Anglophobe, and during the 'twenties and 'thirties a certain number of temporary Communists were produced, but by and large what has been produced has been primarily men with lifelong attachments to Oxford and England. You can see that in all sorts of ways, not least in the activities of such a body as the American Association of Rhodes Scholars, which wears no old school tie, but is much more lively than any public school association I know. That is partly due to the drive of Dr. Frank Aydelotte, but partly to the men's experience of Oxford and the way in which that develops a steadily growing attachment in later life. I should like to read you a passage from this interesting little book, *The Vision of Cecil Rhodes*, by Dr. Aydelotte, one of the earliest Rhodes Scholars:

> "Only in after years, on one of those visits which Americans show such a tendency to make back to the home of their English foster-mother, will he be able to see in true perspective the significance of these eager undergraduate days—days of intense effort, of struggle with hard tasks, of listening to half-heeded words of great teachers, of light-hearted, high-spirited converse with men too many of the best of whom will visit Oxford no more. Then some night as he walks back to his lodgings after dinner at High Table, the moonlight on sleeping walls and towers will thrill him with the sense of the tangled, interwoven beauty of this life that once was his."

That experience has come to many Rhodes Scholars.

Surely there is a great hope for the world in the process of creating a body of men in a number of different countries whose experience may help to set them free from the imprisoning prejudices of the masses. At Versailles, and in our present peace-making, the representatives often found themselves imprisoned within the narrow prejudices of their home publics, which they had neither the means nor the time to correct. The best hope for the future surely is that there should be in

as many countries as possible men freed from those prejudices by their own wider experience.

The Rhodes Scholar in normal times not only spends half the year at Oxford, he usually spends some months on the Continent. That widens his knowledge of the world, but incidentally it has been the experience of many a scholar that the time when he was first profoundly conscious of his kinship with the English people was when he returned from a month or so on the Continent, to find himself once again amongst men whose ways were his ways and whose language he readily understood. There is thus a double value in that Rhodes tradition of European travel. What better means of educating these sort of picked groups than to bring them to Oxford, where the talk perhaps is the best in the world, and enable them during their vacations to make those visits to the Continent which have done so much for them in the past. No wonder the system has been widely copied, not only in some of its educational ideas, but in the practice of bringing young men to other universities in other countries. I suppose there are as many British scholars now being sent by foundations to the United States as are being brought from the United States to Britain.

War-time necessities compelled the suspension of the scholarships. The United States Department of State refused to allow any scholars to come to England after September, 1939, and after 1940 we suspended elections for the Dominions. Large sums were saved, but the income of the Trust has scarcely been increased, because of the general fall in the rates of exchange. The trustees are faced with the necessity of increasing the scholar's stipend from £400 to £500 a year. After the first world war they raised it from £300 to £400 and now, for the present, from £400 to £500.

We tried throughout the war to maintain the other complementary activities of the Trust, which are far less known to the general public than the scholarships themselves. From time to time various other bequests have come to the trustees in addition to the original fund, the bequest of Rhodes himself, and it has been possible to use these for supporting good causes or worthy individual effort of a character which is in accord with the fundamental ideals of the Founder. There have been no public announcements as to the benefactions of the trustees, but despite that, a sufficient stream of applications comes in to represent a greater demand than the trustees have the means to supply, and as the secretary responsible for dealing with those applications, I am constantly impressed by the duplication of effort which goes on among persons devoted to worthy causes. It often happens that individuals or organisations are partly or wholly ignorant of the very existence of other individuals or organisations devoted to almost exactly the same objects as themselves. One of the minor roles fulfilled by these activities of the Rhodes Trust is that of a sort of clearing house which enables one from time to time to put individuals or organisations in touch with each other and enable them to combine and complement each other's work instead of overlapping. Another reflection is that in spite of the multifarious state grants by the Government nowadays there are whole areas of society where Government assistance would be welcome and salutary, but where it is entirely absent, and where very much is left to the activity of voluntary organisations and benefactions such as the Rhodes Trust.

The sort of activities which the trustees support are very largely educational. For

example, a good deal has been given in recent years towards education in Imperial problems, Imperial history and Imperial affairs, such as the admirable popular instruction in Imperial affairs organised by the Y.M.C.A., or the most successful series of lectures under Sir Harry Lindsay at the Imperial Institute. Grants are made sometimes to scholars for learned works: thus one distinguished scholar is receiving a grant to assist in writing a biography of a recently deceased Imperial statesman. An Indian is receiving a grant to assist in the preparation of what we hope will be a scholarly survey of Bengali literature. The Trust has done much for schools, particularly in South Africa, and a great deal for universities. The trustees gave £100,000 to Oxford University when its appeal was before the public some years before the war. I had to send a cheque the other day for several thousand pounds towards the building of the new Imperial Forestry Institute at Oxford. There was a recent grant to Delhi University, and so forth.

Then the trustees up to the war maintained the Rhodes Memorial Lectures at Oxford, which brought to Oxford a range of public figures extending from Field-Marshal Smuts to Professor Einstein, to give a series of lectures, and to reside a week or two in the University, to establish personal contact with dons and undergraduates.

A great deal was given during the war towards hospitality to service men and women from overseas, mainly to the organised hospitality of the Y.M.C.A., the Church Army, the Salvation Army, and similar bodies.

A good deal has been done to further planned emigration, with which the name of Kingsley Fairbridge will always be associated, and the exchange of students and teachers overseas.

It would take too long to particularise all the heads under which the trustees have given their assistance, even during my brief experience of seven years.

All told, I think I can claim that the Rhodes Trust in the course of its forty-odd years of life has done more to promote the main twin objects of the Founder than any other one organisation, and I would say also that it is more obvious even than in the day of the Founder that in these two primary objects—the cohesion and prosperity of the Empire and its close association with America—lies the hope of the world.

My experience of the Rhodes Trust confirms the conclusion to which I should in any event have come as an historian, that, as Rhodes put it with his characteristically frank and boyish phrasing, "We are the finest race in the world", by which I mean we have at the moment, and at this particular crisis in the human story, a more fertile and salutary contribution to make than any other branch of the human race.

I believe that the Rhodes trustees are still administering this great imaginative Trust in a highly imaginative spirit; and if they are, it is perhaps partly because Kipling was right when he wrote, after Rhodes's death, that his "immense and brooding spirit still quickens and controls".

DISCUSSION

Sir HARRY LINDSAY (Director of the Imperial Institute): I should like to ask a question, and then venture a criticism.

Is there anything in the rules for the selection of a Rhodes Scholar which prescribes that his fellows in the college or university shall have any say in his selection?

LORD ELTON: I think the answer to that is, until within the last two or three months that was the practice in one constituency only, in New South Wales in Australia. The Trustees have always disapproved of it, because undergraduate opinion is not usually the best judge. A man may be a very popular undergraduate by expressing the views of his fellows, and a very unpopular one by resisting ill-judged opinions. It has proved from experience that the practice of inviting recommendations and comments from a candidate's contemporaries has discouraged quite a number of excellent potential candidates from coming forward. It is an embarrassing experience to have your contemporaries submitting their judgments on you. It is one thing to come before a Board of Selection of whom you may not even know a name, and another to have your contemporaries judging you. The practice has for the time being been abandoned, even in the one constituency that adopted it.

Sir HARRY LINDSAY: Thank you, Sir. Secondly, may I express the great obligation we feel at the Imperial Institute to the Rhodes Trustees for the support of our Empire Lectures scheme. It has seen us through the very difficult years of the war to a time when, we hope, its roots have become more firmly established than we ever thought possible in the educational system of this country.

May I also add that in all our work, some of it purely honorary, in the interests of the Empire, we Empire organisations, the Royal Empire Society, the Victoria League, the Overseas League, the Royal Society of Arts, the Imperial Institute and others, really work in very close touch with each other, and it is interesting to see how much effort is put into this work? On the whole, in consideration of the breadth of the field and the importance of the issues at stake, I should not like to leave it unchallenged that there is much overlap between these different societies. Our efforts are not wasted, but are divided as much as possible over the whole field.

May I conclude by saying how very much we have enjoyed Lord Elton's paper, and what a clear and effective insight it has given us into the work of the Rhodes Trust.

LORD ELTON: I was not thinking, when I made that comment on the degree of overlapping which can be found among individuals and organisations working for the same ends, of the great established societies and organisations like the Royal Empire Society or the Imperial Institute, but rather of the younger bodies still feeling their way, with rather more specialised interests than the great organisations like the Royal Empire Society. I can assure you the overlapping does exist there. You may find two men who have spent a year or two working on the biography of someone, who have no idea that anyone has touched this subject before. A foundation simply to act as a clearing house of ideas might be extremely valuable.

THE CHAIRMAN (VISCOUNT BENNETT): I am bound to say I incline somewhat to the view just expressed by the lecturer as to overlapping. I have noticed it once or twice myself, and I did suggest once that we might have some clearing house in connection with matters of that kind. I am very pleased indeed to hear that the Rhodes Trust exercises the function it does to the extent that has been indicated by the lecturer.

I think, Lord Elton, in extending to you the thanks of this audience, I may say that I have learned to have so high a regard for your abilities in matters of this kind that I should have been greatly disappointed if you had not delivered an instructive and interesting lecture. I therefore, on behalf of this audience, extend to you their very sincere thanks for the really instructive (in the proper sense of the term) lecture you have delivered. I think there is one thought we must carry away with us, the tremendous influence that one man with a proper vision can exercise on the world. It has been said that one man cannot do much. One-man movements, as a matter of fact, very often play a very definite part in our civilisation. That has been so with us, and it will continue to be so.

From what I have observed in Canada with respect to the Rhodes Trust, it has been a spur and an incentive to men to do their best, and by his example Rhodes has left an

effect on the minds of the younger men of our time that cannot be exaggerated or overstated. I am sure that must be so even in this old country, where the circumstances are entirely different from those of a new country.

Sometimes the selections have not met with universal approval. I daresay that happens here, but in a new country many of the Rhodes scholars have made a very real contribution to their time. Perhaps there has been a little disappointment in the aggregate, but one of my young associates in the practice of my profession is a Rhodes Scholar now in Japan, carrying forward the prosecutions on behalf of the Allied Powers against the Japanese war criminals. He was a Rhodes Scholar of distinction, and his training at Oxford left upon him an indelible mark—even upon his pronunciation.

We have had a very delightful afternoon. It now remains my duty to say this meeting stands adjourned.

Sir HARRY LINDSAY proposed a vote of thanks to the Chairman, which was carried with acclamation, and the meeting then terminated.

GENERAL NOTES

EXHIBITION OF APPLIED PHOTOGRAPHY.—An exhibition, demonstrating the widespread applications of photography in science and industry, is being held in Australia House by Messrs. Kodak Limited. It illustrates the use of photography in such various branches of research and technical development as X-ray photography, X-ray diffraction and electron micrography, spectrography, photomicrography, high-speed photography and micro-photography for recording documents, etc., and their application to numerous aspects of science, industry and education. The exhibition is open from 10 a.m. to 5.30 p.m. daily, (except on Saturday 10th and Sunday 11th May). Admission is by invitation card, obtainable from Industrial Sales Department, Kodak Limited, Wealdstone, Harrow, Middlesex, and on 15–16th May the exhibition will be open to the public.

SCHOLARSHIPS AND RESEARCH FELLOWSHIPS IN THE TEXTILE INDUSTRY.—The endowments known as the Sir Walter Preston Scholarships and Research Fellowships annually offer assistance to works apprentices, university students and graduates to follow studies connected with the textile industry. The Trustees of the scheme are now calling for applications for this year's awards, which are tenable at the University of Manchester in the Faculty of Technology.

The Undergraduate Scholarships are awarded to works apprentices and students leaving secondary schools, classified in three groups. The awards run for three or four years, and have an annual value of from £200 to £300 per annum, depending on year and group.

The Post-Graduate Scholarships are offered to Honours Graduates in Science or Engineering. The normal tenure is three years and value £300 to £350 a year. Research Fellowships, of value £400 to £550 a year for from two to four years, are awarded to scholarship holders in the scheme, or other university graduates appropriately qualified.

Applications for Undergraduate Scholarships must be forwarded not later than June 7th, 1947, and for Post-Graduate Scholarships and Research Fellowships not later than July 12th, 1947, to the Secretary, the Sir Walter Preston Scholarships and Research Fellowships, c/o Textile Machinery Makers Limited, 60 Huddersfield Road, Oldham, Lancs, from whom application forms and full details may be obtained.

OBITUARY

JOHN DOWNIE FALCONER.—We regret to announce the death, on April 16th, of Dr. John Downie Falconer, M.A., D.Sc., F.R.G.S., F.R.S.E., F.G.S. Dr. Falconer was born in Midlothian in 1876 and was educated at the universities of Glasgow and Edinburgh. From 1901 to 1904 he was assistant to Professor James Geikie, the celebrated Scottish geologist. He then went to Northern Nigeria as principal of the Mineral Survey and returned to Glasgow University in 1911 to take up the post of Lecturer in Geography. He returned to Nigeria in 1916, and was made Director of Geological Survey for Nigeria, in which position he served from 1918 to 1927. From 1928 to 1934 he was Geologist to the Republic of Uruguay. He published numerous papers and books on geological subjects, and also writings of general interest arising from his travels. Dr. Falconer was a Fellow of the Society from 1936 to 1946.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, MAY 12..Farmers' Club, at the Royal Empire Society, W.C.2. 2.30 p.m. Martin Jones, "**Ley Farming and the Livestock Population.**"

Geographical Society, Royal, S.W.7. 5.30 p.m. Dr. E. M. J. Campbell, "**The History of the Atlas.**"

Kinematograph Society, British, at the Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester.** 10.30 a.m. Leslie Knopp, "**Auditorium Requirements in Sound Film Presentation.**"

At the Neville Hall, Grainger Street, **Newcastle-on-Tyne, 1.** George H. Sewell, "**Problems of Substandard Projection.**"

University of London, School of Slavonic and East European Studies, W.C.1. 5 p.m. W. K. Matthews, "**Baltic Origins.**"

At the Senate House, W.C.1. 5.30 p.m. Rt. Hon. Sir John Anderson, "**Economics in the Sphere of Government.**"

At School of Slavonic and East European Studies, W.C.1. 6 p.m. L. Dabasi-Schweng, "**The Social Problems and Achievements of New Hungary.**"

Victoria Institute, 12 Queen Anne's Gate, S.W.1. 5.15 p.m. D. R. Mace, "**Sex Morality.**"

TUESDAY, MAY 13..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. G. W. Sutton and E. M. Lee, "**Future Trend of Component Design for the Services.**"

At the Cavendish Laboratory, **Cambridge.** 6.30 p.m. W. Bleaney, J. W. Ryde and T. H. Kinman, "**Crystal Waves.**"

Illuminating Engineering Society, at the Institution of Mechanical Engineers, S.W.1. 6 p.m. Dr. N. A. Halbertsma, "**Illumination.**"

Instrument Technology, Society of, Dr. J. Yule Bogue, "**The Measurement of Non-Cyclical Biological Phenomena.**"

University of London, London School of Economics and Political Science, W.C.2. 5 p.m. W. W. Rostow, "**The Shape of the British Economy in the 19th Century.**" Lecture I.

At School of Slavonic and east European Studies, W.C.1. 6 p.m. Andrew Rothstein, "**Soviet Institutions—Agriculture.**"

WEDNESDAY, MAY 14..Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. Dr. Waldemar Borgquist, "**Recent Research and Development Work in Sweden on High-Voltage A.C. and D.C Power Transmission.**"

Kinematograph Society, British, at the G.B. Theatre, Film House, Wardour Street, W.1. C. G. Heys-Hallett, "**Some Special Purpose Arcs.**"

Sanitary Institute, Royal, at 90 Buckingham Palace Road, S.W.1. 3 p.m. Dr. W. H. Bradley, "**The Control of Smallpox.**"

Science, British Association for the Advancement of, at the Royal Institution, W.1. 5.30 p.m. Professor E. D. Adrian, "**The Sense of Smell.**"

University of London, at the Architecture Threatre, Gower Street, W.C.1. 5 p.m. Dr. Johannes Wilde, "**Michelangelo and Sebastiano Veneziano.**" Lecture I.

THURSDAY, MAY 15..Chemical Society, at the University **Sheffield.** 5.30 p.m. Professor J. B. Speakman, "**Some Relationships between the Structure and Properties of Natural and Synthetic Fibres.**"

Royal Society, W.1. 4.30 p.m. Sir Alfred Egerton and G. J. Minkoff, "**The Formation of Hydrogen in the Combustion of H at Low Pressures.**"

Town and Country Planning Association, 28 King Street, W.C.2. 1.15 p.m. Max Lock, "**Planning Teamwork in Action in the Hartlepools.**"

University of London, London School of Economics and Political Science, W.C.2. 5 p.m. H. N. Brailsford, "**The Life-Work of J. A. Hobson.**"

At School of Slavonic and East European Studies, W.C.1. 6 p.m. F. Friedeberg-Seeley, "**Historical Background of Russian Literature to 1881—Series II.**" Lecture III.

FRIDAY, MAY 16..Electronics, Institution of, at the Reynolds Hall, College of Technology, **Manchester.** 6.45 p.m. A. Levins, "**Radar Navigation.**"

University of London, at the Architecture Theatre Gower Street, W.C.1. 5 p.m. Dr. Johannes Wilde, "**Mechelangelo and Sebastiano Veneziano.**" Lecture II.

At School of Slavonic and East European Studies, W.C.1. 6 p.m. "**New Hungary and her Neighbours: possibilities and prospects of co-operation in the Danube Valley after World War II.**"

SUNDAY, MAY 18..Kinematograph Society, British, at the G.B. Theatre, Film House, Wardour Street, W.1. 11 a.m. H. J. Odell and A. T. Sinclair, "**Sound Reproducing Equipment.**"

MONDAY, MAY 19..University of London, School of Slavonic and East European Studies, W.C.1. 5 p.m. W. K. Matthews, "**Medieval Baltic Tribes.**"

TUESDAY, MAY 20..Electrical Engineers, Institution of at Queen's University, **Belfast.** 6.45 p.m. E. C. S. Megaw, "**Radiolocation.**"

University of London, London School of Economics and Political Science, W.C.2. 5 p.m. W. W. Rostow, "**The Shape of the British Economy in the 19th Century.**" Lecture II.

At School of Slavonic and East European Studies, W.C.1. 6 p.m. Andrew Rothstein, "**Soviet Institutions—Trade.**"

WEDNESDAY, MAY 21..Electrical Engineers, Institution of, at the Admiralty Signal Establishment, Haslemere, **Surrey.** 7 p.m. W. Ross, "**The Development and Study of a Practical Spaced-Loop Radio Direction-Finder for High Frequencies.**"

Metals, Institute of, at the Institution of Civil Engineers, S.W.1. 6 p.m. Sir Wallace Akers, "**Metallurgical Problems Involved in the Generation of Useful Power from Atomic Energy.**"

THURSDAY, MAY 22..Chadwick Trust, at The Town Hall, **Cheltenham, Glos.** 3 p.m. Sir Arthur NacNalty, "**Advances in preventive Medicine during the War of 1939-1945.**"

University of London, School of Slavonic and East European Studies, W.C.1. 6 p.m. F. Friedeberg-Seeley, "**Historical Background of Russian Literature to 1881—Series II.**" Lecture IV.

FRIDAY, MAY 23..Electrical Engineers, Institution of, at the Training College Hall, Park Place, **Dundee.** 7.30 p.m. J. Hacking, "**The Generation and Wholesale Distribution of Electricity.**"

University of London, Architecture Theatre, Gower Street, W.C.1. 5 p.m. Dr. Johannes Wilde, "**Michelangelo and Sebastiano Veneziano.**"

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4743 *FRIDAY, MAY 23rd,* 1947 Vol. xcv

DEATHS OF SIR THOMAS HOLLAND, SIR HUMPHREY LEGGETT AND SIR FREDERICK GOWLAND HOPKINS

We announce with profound regret the deaths of Sir Thomas Holland, K.C.S.I., K.C.I.E., D.SC., LL.D., F.R.S., a Vice-President and Albert Medallist of the Society, and former Chairman of the Council, of Major Sir Humphrey Leggett, D.S.O., formerly Chairman of the Dominions and Colonies Section, and of Sir Frederick Gowland Hopkins, O.M., D.SC., LL.D., F.R.C.P., F.R.S., an Albert Medallist. An obituary article by Professor C.S. Gibson on Sir Thomas Holland will be found on p. 438 of this issue; obituary notices of Sir Humphrey Leggett and Sir Frederick Gowland Hopkins will be included in the next issue of the *Journal.*

THE SOCIETY'S ALBERT MEDAL FOR 1947

The Council have awarded the Albert Medal for 1947 to Sir Robert Robinson, M.A., D.SC., LL.D., F.R.S., Waynflete Professor of Chemistry in the University of Oxford and President of the Royal Society, "for his outstanding contributions to the advancement of organic chemistry".

During the last thirty years Sir Robert Robinson has become the recognised leader in this science. More than any other organic chemist he has made contributions of the highest importance to our knowledge of the mechanism of organic chemical reactions which have inspired other workers in organic chemistry everywhere. Science, and an appreciation of harmony in nature, combined to make his studies of the constitution of the colouring pigments of flowers a delight not only to chemists but also to all who appreciate natural beauty. The manner in which he has indicated how plant alkaloids may be evolved in nature and his contributions to the elucidation of the difficult problem of the constitution of the alkaloids of the strychnine group have never been surpassed by any previous worker.

We shall always remain indebted to him for the knowledge and genius which he has exercised in his elegant syntheses of compounds of the sterol group and other hormones, whereby healing and alleviation of physical suffering may be achieved. His recent contributions to the chemistry of the antibiotic substances, particularly of the penicillins, will prove to be of the greatest importance and benefit to mankind.

The Royal Society of Arts is proud to add his name to its list of distinguished holders of the Albert Medal. Details of the arrangements to be made for the presentation of the medal to Sir Robert Robinson will be announced later.

REMAINING MEETINGS OF THE SESSION

WEDNESDAY, MAY 28TH, at 5 p.m. (*Trueman Wood Lecture*).—"MODERN ASTRONOMICAL INSTRUMENTS". By Sir Harold Spencer Jones, M.A., SC.D., F.R.S., Astronomer Royal. The Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Society, in the Chair. (Illustrated by lantern slides.)

WEDNESDAY, JUNE 11TH, at 5 p.m. (*Selwyn Brinton Lecture*).—"INTERNATIONAL GOTHIC AND ITALIAN RENAISSANCE PAINTING". By Sir Kenneth Clark, K.C.B., Slade Professor of Fine Art, University of Oxford. Professor T. S. R. Boase, Director, Courtauld Institute of Fine Art, in the Chair. (Illustrated by lantern slides.)

MEETING OF COUNCIL

A meeting of the Council was held on Monday, May 12th at 2.30 p.m.

Present: Lord Bennett (in the Chair); Mr. F. H. Andrews; Sir Frank Brown; Major W. H. Cadman; Sir Atul Chatterjee; Professor C. S. Gibson; Mr. E. W. Goodale; Sir William Halcrow; Miss Caroline Haslett; Mr. Basil Ionides; Sir Harry Lindsay; Sir Henry McMahon; Mr. G. K. Menzies; Mr. J. A. Milne; Mr. Keith Murray; Mr. E. M. Rich; Mr. A. R. N. Roberts; Captain A. H. Ryley; Mr. E. Munro Runtz; Sir Frank Smith; Mr. J. G. Wilson; Mr. William Will, and Miss Anna Zinkeisen; with Mr. K. W. Luckhurst (Secretary).

The following were duly elected Fellows of the Society:

Baxter, Lionel David Mackenzie, O.B.E., Winnipeg, Canada.
Beristayn, Dr. George de, Buenos Aires, Argentina.
Born, Henry, London.
Boyd, James William Wyllie, Shanghai, China.
Campbell, Sir Alexander, M.C., E.D., M.A., Croydon, Surrey.
Coker, George Baptist Ayodola, London.
Cooke, Major Charles Martin, R.E., New Delhi, India.
Coulson, Ernest Harrison, Braintree, Essex.
Cowing, Miss Gwneth Ray, Barnet, Herts.
Coyle, Charles John Reginald, Montreal, Canada.
Dale, Thomas Lawrence, Carfax, Oxford.
Elford, Ernest John, London.
Evans, Percy, M.A., London.
Fry, Major Arthur Malcolm, London.
Gardner, Miss Maude, B.A., Secunderabad, India.
Goodeve, Sir Charles Frederick, O.B.E., D.SC., F.R.S., London.
Halle, Robert, B.SC., PH.D., 5 Brierley Hill, Staffs.
Harland, William Henderson, Thronton Heath, Surrey.
Harold, Miss Eileen Gwladys, M.A., London.
Heywood, Tom Turner, Rochdale, Lancs.
Hoare, Engineer Rear-Admiral Dennis John, C.B., Wraysbury, Bucks.
Holdcroft, Harold, Stoke-on-Trent, Staffs.
Hooker, Captain Michael Ayerst, B.A., London.
Killanin, The Right Hon. Lord, M.B.A., M.A., co. Galway.
Lacey, Gerald, C.I.E., B.SC., London.
Leyshon, Howard Morgan Edward, Leeds.
Lindley, Albert Thomas, B.SC., Gainsborough, Lincs.
Lloyd, Llewelyn Southworth, C.B., M.A., Gerrards Cross, Bucks.
Macleod, Murdoch, Glasgow.
Marsh, Reginald, New York, U.S.A.

May, Robert William, Swansea, Glamorgan.
Moos, Keki M., East Khandesh, India.
Moung, U Hla, B.Sc., Myingyan, Burma.
Nicholls, Lieut.-Colonel Cyril George, Bombay, India.
Padmore, Harry James, Grenada, B.W.I.
Read, Flight-Lieutenant Paul, R.A.F.O., Nairobi, Kenya.
Redgment, Peter George, M.A., Haslemere, Surrey.
Robertson, Howard, M.C., London.
Schwarz, Samuel, B.Sc., London.
Sein, U Ba, Insein, Burma.
Spence, William Robert, Dungannon, Co. Tyrone.
Thompson, Henry, Barrow-in-Furness, Lancs.
Turner, John Stanleigh, J.P., Leicester.
Watterson, Norman Frederick, B.Sc., Bury St. Edmunds.
Wendon, Reinhard David, Littlehampton, Sussex.
Whitehead, Arthur Percy, M.C., B.A., Hereford.
Williamson, John Gregory, Birmingham.
Wilson, James, B.Sc., Birmingham.

The following was duly elected an Associate of the Society:

Gardner, Miss Audrey T., B.A., Secunderabad, India.

Final consideration was given to the award of the Albert Medal (see notice on page 407).

The Balloting List for the new Council was completed.

Plans for the 1947 Competition of Industrial Designs were approved.

The proposed new Bankside Power Station was considered and a resolution passed (see page 409).

Professor C. S. Gibson and Major W. H. Gibson were appointed to represent the Society at the Eleventh International Congress of Pure and Applied Chemistry

It was decided that the Ordinary Meetings of the Society should next Session be held at 2.30 p.m.

A quantity of formal and financial business was transacted.

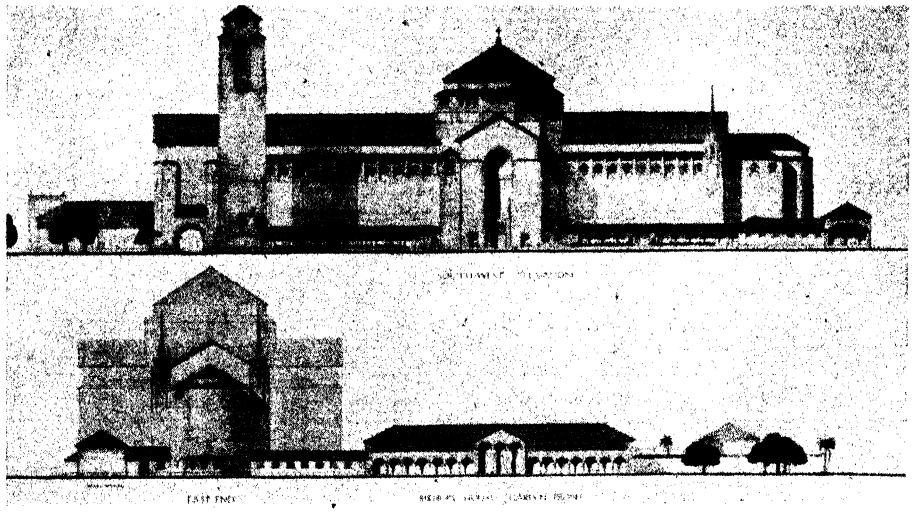
BANKSIDE POWER STATION

The following is the text of a Resolution passed at a Meeting of the Council of the Society on Monday, May 12th, 1947:

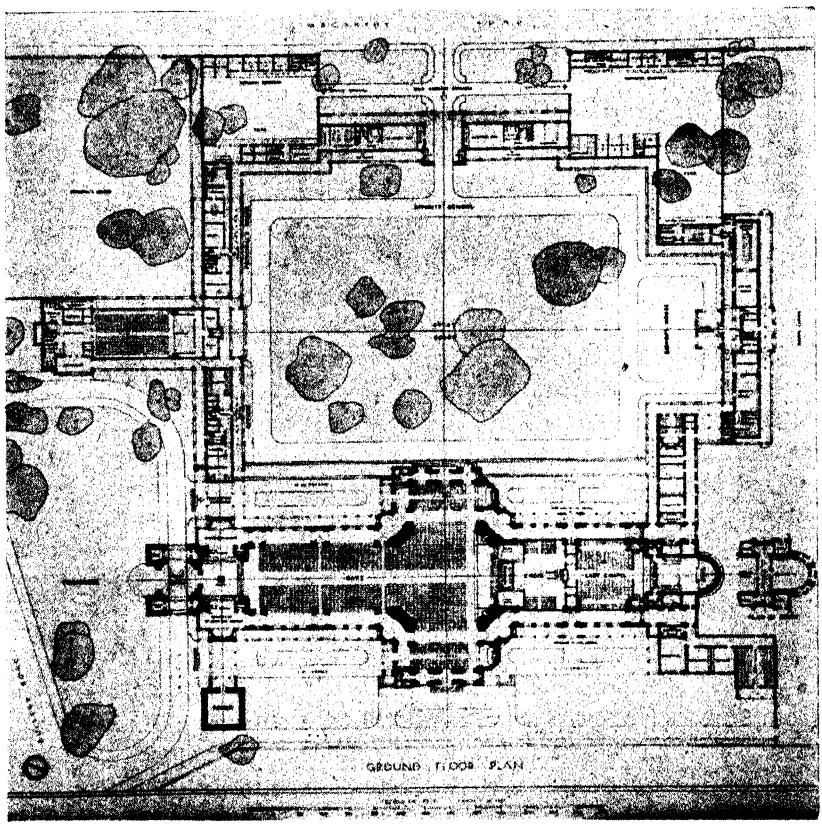
> The Council of the Royal Society of Arts, having heard of the proposal to erect an Electricity Power Station at Bankside, Southwark, are of the opinion that the carrying out of such a project would be most regrettable in view of the threat the same would constitute to the æsthetic position of St. Paul's Cathedral and to the cultural development of the South Bank of the Thames between the bridges, and urge re-consideration of the whole matter.

COLOMBO CATHEDRAL COMPETITION : PRIZEWINNING DESIGN

The two drawings reproduced overleaf are part of the design by Messrs. Pinckney and Gott, of 7, Gray's Inn Square, London, which won first place in the Colombo Cathedral Competition. The scale of these reproductions is approximately 140 feet to the inch in the elevations and 150 feet to the inch in the plan.



The elevations of the Cathedral and associated buildings from the South-West (top) and from the East, from the design by Messrs. Pinckney and Gott which won first place in the Colombo Cathedral Competition



Ground floor plan of the first premiated design. Reading clockwise round the Great Court from the Cathedral, at the bottom of the picture, the plan shows: The Diocesan offices and Hall (centre left), the Principal's house and Divinity School, and the Bishop's house (right)

ECONOMIC RECONSTRUCTION

(VI) PRODUCTION

By the Right Hon. OLIVER LYTTELTON, D.S.O., M.C., M.P.

Seventeenth Ordinary Meeting, Wednesday, April 16th, 1947

The Right Hon. VISCOUNT BENNETT, K.C., P.C., LL.D., President of the Society, *in the Chair*

THE CHAIRMAN: The paper to be read this afternoon is one of a series on economic reconstruction, organised by one of the Fellows of the Society, and the large attendance shows the interest which is taken in that subject.

It is my very pleasant duty to introduce the author of the paper, Mr. Oliver Lyttelton, who is to speak on production. During the war Mr. Lyttelton had much to do with the greatest purchases which this country had ever made, in respect of metals in particular. I suppose I am not at liberty to tell you all I know about what he did, but, at pre-war prices, the net profit to this nation was so large that he is afraid to mention it, because it would shock your sense of the eternal fitness of things that the Government should make so much profit and that the profit should not belong to some private enterprise!

I will not do more than say to you that in our speaker this afternoon we have a statesman and an administrator of proved capacity. The administrator is very important in these days. I am not very much concerned about the talk that we have on the subject of nationalisation, for in the end it all comes down to the question of the person who is going to manage the business, and who that person is is a matter of great importance. Mr. Lyttelton was asked to undertake that work for the State during the war, and he did it with such success that he established a reputation which no doubt everyone present would agree, after hearing Mr. Lyttelton's paper, was fully deserved.

The Right Hon. OLIVER LYTTELTON then read the following paper:

I am very glad to be here and to read a paper to you, for three reasons, the first being that I feel honoured by your invitation and the second being that Lord Bennett is in the Chair. He has given me advice and I have followed it, with what results I do not know, but I am particularly gratified that he is presiding this afternoon. The third reason is that reading a paper or giving a lecture is a phrase that sounds very sweet in a politician's ear, because it means hearing his own voice with a minimum of interruptions. These are the occasions when he gets away with it, and that seldom happens at other times.

I remember some time before the war staying in a country house, and the party being a large one, the guests were dining at two tables. An argument arose at one of them about who was Prime Minister at the time of the Battle of Waterloo. Curiously enough there was some difference of opinion, and even a bet or two was made. Suddenly somebody said "What fools we are to be arguing when a senior history don of Trinity College, Cambridge, is dining at the other table. We had better ask him". So we did. He replied "I shouldn't know. You see I only go down to 1489".

Our age is an age of specialists. Knowledge in our century has grown with a rapidity which is often unnoticed, and we are still more apt to forget the ever-increasing rate at which it is growing day by day. In the last century my great-uncle, Mr. Gladstone, when he was Prime Minister, wrote a book about Homer, and it was read and taken seriously as a contribution to scholarship by scholars in both of the oldest universities. To-day it would be almost the sole work of a lifetime to make

a significant contribution to Homeric scholarship. So the Royal Society of Arts, in asking me to address you about production, a word which hides a myriad skills and a myriad pieces of special knowledge of this industry or that, have given me a difficult task, and are even perhaps asking me to step out of the usual path of 1947. But I think one thing emerges, and that is that I cannot and must not descend to details. Indeed, if I did, I should have to negotiate a long lease of your hall as well as a long lease of your patience. I have no right to do the one, nor have I the audacity or the ill-manners to do the other. So I must try and walk along the razor edge of generality. I will try and lay out the subject under three broad categories.

First, the supply of raw materials, which clearly comes first in point of time. Secondly, industrial layout, the buildings, the plant and the machinery of production. Thirdly, the workers and the management, in short, the human side. But before I deal with each of these main subjects I must turn aside for a moment to say that the organisation of production depends upon having all the individual operations in phase.

At this point it is perhaps necessary to make an excursion into the subject of so-called economic planning. To plan centrally the production of a particular piece of mining machinery, let us say, and to get the production of that particular machine advanced in the queue of production by centralised planning, probably involves the individual planning of some hundreds of different components or ingredients. Anyway, the task of determining the priority which is to be given to a particular machine can only be entrusted to a senior wrangler and a bookmaker acting as a committee of two, or better still to an official astrologer. Let me explain what I mean by an illustration.

An application for a priority licence is made by the manufacturer of a particular piece of apparatus who wishes to export it to a soft currency country, perhaps to the sterling area. Contained in this machine is $15,000 worth of molybdenum, a metal which has to be imported from the U.S.A. Another manufacturer on the same day applies for a priority licence to export a piece of apparatus to a hard currency country. This piece of apparatus requires not only $45,000 worth of molybdenum, but four times the amount of copper contained in the first application.

"Well", you may say at this point, "I can see that the thing might be worked out". But unfortunately this type of calculation has got to be made over all the ingredients of the machine, and the relevant stresses and strains caused upon our dollar position and the ultimate receipt of either soft currency or hard currency has got to be assessed. There is really only one way to do this, which is to guess or to toss up in the office. However, if His Majesty's Civil Service had to toss up over the entire volume of our trade, they would very soon cause a shortage of silver or cupro-nickel currency. There is no greater or more popular fallacy than to imagine that priority systems can work upon a detailed scientific basis. They never worked in war, where at least the demand for the end product, as the Americans call it, was known, and where the Government itself was the purchaser of the great bulk of the production of the country. But when the demand for the end product is also an unknown, as it is in peace, then the task is beyond the calculation of ordinary human beings. Even a Socialist would have to admit an element of crystal gazing in judging this type of problem.

You may think that this is a slight digression from my subject, but you would be wrong, because the phasing of production begins with the purchase of the necessary raw materials, and their delivery in phase throughout the whole process to which they are ultimately to be subjected.

So that this brings me to my first heading—raw materials. As I have to compress my argument within quite a short space of time, let me say that one of the most useful things which could be done to get production flowing evenly would be the restoration of free markets through the commodity exchanges, and the restoration as far as possible of the price mechanism in the purchase of other raw materials, which in the past have not been dealt with on terminal exchanges.

The commodity exchanges would, it is true, have to be rationed in the amount of hard currency, notably dollars, which they could use, chiefly in order to prevent the export of capital. But it is not often understood how many transactions are cleared, how many facilities are provided by the turnover of a single contract for rubber or copper or cotton in a free market. A great number of transactions cancel themselves out, and the residue which is left, representing a plus or minus, that is to say an import or an export, represents in free conditions either the deficiency or the surplus which the country has in that particular raw material. May I illustrate the first of these points from a trade in which I used to be engaged, the metal trade?

In Italy, the vine growers are experiencing warm sun and heavy showers during the campaign, as it is called. I am a manufacturer of sulphate of copper, which is sprayed on the vines. I therefore get a new order for sulphate of copper because the showers are washing it away. I immediately buy copper futures in London, in order to cover myself against a rise in the price of copper whilst I am making the extra sulphate. During the campaign in France, however, which takes place nearly at the same time, there is no rain, the sunshine is unrelieved (as they would say) by showers. Their demand is less than expected. A French manufacturer of sulphate finds himself over-bought in copper and he therefore sells copper futures in London. Supposing that these transactions happened to be of exactly the same size, no dollars would have been used, no permits or controls would have been enforced, and yet both manufacturers, the one British and the other French, would have had a facility enabling them to conduct their industrial business without speculating in the price of their raw material. I am not going into the commission earned in London on the transaction; it would be irrelevant to my present subject. Again, the shortage of materials is made much more severe by the over-centralised planning of their distribution. Let me give one instance. The Government have shut down the Liverpool Cotton Exchange. I do not think that the President of the Board of Trade would dissent if I summed up his argument in favour of this measure by saying that it is done in the interests of the stability of the price of raw cotton to the spinner; at least his spokesman in the Committee stages of the Bill said just that.

Now to stabilise the price of cotton is, of course, perfectly possible in any given country, just in the same way as it is quite possible to prevent your seeing a burglar by putting your head under the bedclothes. Fluctuations in the price of cotton are inherent in the commodity, which is an agricultural commodity subject to rain, sun and pest, and even His Majesty's present advisers have not been able to control any of these three factors. So that all that the Board of Trade intends to do about

cotton, expressed in a medical analogy, is to replace the mercury in the thermometer by a piece of wood, to paint 98·4 on the wood, to put the thermometer into the patient's mouth at intervals and say "My boy, you're all right, your temperature is normal".

I must drive home my point by yet another illustration of what is happening to-day. A Government in South America, let us suppose, calls for tenders for the supply of some electric locomotives. Once upon a time the manufacturer used to be able to cover himself against rises, for example, in the price of steel and copper, first while the tender was out, and secondly during the two years that it takes to manufacture the locomotives, by buying futures or getting firm prices for future delivery. He cannot do so now, there is no free market and the only prices he can get are the current prices of steel and copper at the time when he takes delivery. That time will on the average be about a year hence. How can he quote firm prices for the locomotives to the South American Government under these conditions?

Lastly, before I leave the subject of raw materials, I must remind you that the operations of a free market are not inherently wasteful of our exchange resources, for if the market imports more than it exports, it means that that amount of the raw material is being used in manufacture here. Exchange control is really only necessary to prevent the export of capital. I cannot go further, in the time at my disposal, into the subject of raw materials, but so far I have tried to show that the first necessity, that is in point of time, is a proper supply, in proper phase, exactly distributed with the aid of the price mechanism, of the raw materials.

I now turn to the subject of labour. The fact that industrialists are now alarmed not so much by the shortage of labour as by the shortage of material will, I trust, not be regarded by anyone as more than a short-term view. I think that recent events have also caused this alarm to spread to workers themselves. The appearance of considerable pockets of apparently obdurate unemployment, due to the mismanagement of fuel, and due to a mistaken monetary policy, tend to increase the natural protective measures which may be taken by employers and capitalists against loss and bankruptcy on the one hand, and by workers against unemployment on the other. Restrictive measures by either side of industry in the present economic state of our health are poisonous.

In fact, we must look beyond our present discontents and fix our eyes upon the long-term problems of our country. If we make the assumption, which I admit you have to be optimistic to make, that our affairs will be reasonably managed, then there is a long-term shortage of labour. There are more jobs to be done than there are men and women to do them. As far as I can calculate in round figures, our shortage of labour lies somewhere between six or seven hundred thousand and a million effective workers. I cannot go into the calculation upon which I base these figures, but I do not believe that economists as a whole would dissent from the figures within this bracket. For employers and workers to grasp this fact is one of the essentials in understanding our crisis, and one of the essentials upon which measures to meet it must be taken. I apologise for descending into platitude and the obvious, but if these figures are true then we can only balance our accounts by getting greater productivity from our existing labour force.

I want to discuss shortly the three attacks upon this problem which are necessary

if we are to reach our objective. The left flank attack should be directed by the employer upon the objective of improving in every way possible industrial layout and working conditions.

The word layout, in a narrow sense, of course only means the organisation of a factory, or a plant, or a mine, or a brickworks so that the handling of materials is reduced to the lowest possible volume. But layout really goes further than this, and layout must give the worker a light, airy, well-warmed or well-cooled, tidy, clean, healthy and above all cheerful place in which to work. The Americans, with their vast domestic market and very high wages, have perforce given greater attention to industrial layout than we have, and many of our industries have much to learn from them in these matters. Let me give an example.

I used to be a director of a large mining company in Australia, and the company sank a new shaft. All the latest information had been collected about American methods, and I think that company has as modern an arrangement of its shaft, changing rooms, shower baths and administrative block as any base metal mining company in the world. The temperature at the low levels of the mine is fairly high. In the new layout the shaft debouches into the actual building which contains the shower baths and changing rooms. A miner coming up from 1,300 or 1,400 feet does not have to walk from the head of the shaft in the cold air before changing his clothes or washing off the sweat from his body. He has his shower bath and changes under the most hygienic conditions. His pores are closed before he leaves the building. He catches cold far less often than he used to, and he feels he is being looked after, his wife feels that he is being looked after, and both are more contented. I think everyone benefits, and sickness—which is now known by the genteel words "involuntary absenteeism"—is reduced. This is a small illustration of how layout goes beyond the mere question of handling materials efficiently.

The next thing, of course, is mechanisation within the industrial layout. Perhaps the biggest dividend it pays is that it enables the skilled workers to be concentrated on those operations which really require skill, and it leads to the repetition processes being undertaken by unskilled or semi-skilled labour. The result, of course, is increased production per man-hour and per man-week. I saw in this country during the war operations which could have been done on automatics in large quantities with little supervision being manufactured by hand by skilled men. This is waste, and we cannot afford it.

In parenthesis, it would be a mistake to suppose that we should aim at the same degree of mechanisation as that achieved by the Americans, because exports are a much larger proportion of our national economy than that of the Americans. We must therefore have a more flexible production line; exports are more mercurial than home demand, and therefore we must be prepared by a flexible production to meet the changing demands of our foreign customers. These demands often depend in the primary countries upon the success or failure of crops or harvests.

The British engineering industries are well placed to re-equip themselves and to increase the efficiency of their mechanisation. We had, for example, over 180 machine tools at the end of the war for every hundred we had before the war, and a great opportunity therefore presents itself—of which I believe they are taking full advantage—to re-equip the engineering industries on the most modern lines. The

same advantages, however, are not present in many other industries, notably in those which have either been shut down altogether in the war, or which have worked at much lower rates of production, or which have been concentrated under the concentration scheme, of which I was the author.

The industrialist wishing to increase and improve the mechanisation of his plant is faced by the difficulty of getting deliveries of machinery from manufacturers in this country. This is partly due to the immense demand which six years of abstinence during the war has caused, and partly due to over-export of machinery from this country. It is also due to the cumbersome and creaking Government machine. The industrialist has to watch battledore and shuttlecock being played between several Government Departments concerning licences, permits, clearances, regulations about town and country planning, and the whole rigmarole. Persistence and bad temper rather than patience and sweet reasonableness will often break these barriers down, and they must be broken down. It is only too easy for the industrialist to throw up the sponge and retire to the country utterly frustrated.

So much for what I have described as the left flank attack on the problem. I now turn to the centre attack. At first sight it may appear to you to be too small a matter or too trivial to form part of the general argument which I am laying before you.

The centre attack is directed towards reducing the fatigue in the worker inherent in all industrial operations. This is generally known as time and motion study, and I really believe that it is not too much less important than the other two attacks upon the problem, with one of which I have already dealt. To apply time and motion study to a large body of operatives requires a lot of human understanding, and it requires in the employer a high sense of fairness, also a well-trained body of rate-fixers in whom the workers have confidence. But if industrialists keep in their minds that the object of time and motion study is reduction of fatigue by the operative, they will then be working on a sound principle.

If I am able to do a simple operation with half the fatigue, by the expenditure of half the effort which I now put into it, I shall clearly with the same effort tend to produce twice as much, if the other ingredients of production are to be correspondingly accelerated. If I produce twice as much, that extra production should certainly be reflected in a sharp rise in my rate of earnings—I did not say wages, I said earnings—which I collect at the end of the week.

There remains the most important of the three attacks upon the subject, namely the human side of the problem, the right flank attack as I call it. It should have the directive of seeing that every worker understands the terrible gravity of the economic crisis which is now pressing upon us, the intensity of which I fear is growing from day to day, and will continue to grow unless far-sighted measures are taken to reverse it. Every means of publicity should be used—even the King's English if it can be found somewhere—to throw into relief the plain, inescapable truth that a higher standard of life cannot be secured without greater productivity.

Now you will notice that I have used two phrases—standard of life and greater productivity—which transgress my appeal about the King's English, and I have done it on purpose, because it enables me to say that I do not think we should talk about the standard of life or greater productivitiy in public. We should substitute for such words as "the standard of life" some such phrase as this: "We shall not

get enough to eat, we shall not get enough to wear, we shall not get enough to cook our dinner and warm our bodies". And wherever it is applicable the phrase greater productivity and greater production should be changed to "more or harder work".

I would like to make a slight digression here. I do it with some diffidence. It seems to me that to place leisure as the one star in heaven is singularly unintelligent in the present state of human nature and the world in which humans live. There is no task which requires a higher or a wider education than how to spend leisure with happiness. How often have I seen officials of companies retire after forty years' service, retire after forty years of catching the 8.30, and with a sigh of relief look forward to a period of elegant and enjoyable leisure. They are nearly always disappointed, sometimes they die quite soon. Nothing destroys people's health so quickly, in my experience, as a lack of interest, and before we erect leisure as the god to which we should all pay obeisance, let us be quite sure that it adds to our real happiness.

Naturally I want to see an industrial economy founded on high wages and short hours, but these must follow as a result of higher production and not precede it in the hopes that it will come.

I must at this point say again what I have said for a long time and that is that incentive must be brought into play. Never mind that incentive is only our old friend the profit motive in a more respectable garb. Happily we are busy trying to remove the sanctions that used to spur people to work, fear of unemployment or illness during a man's working life, fear of the workhouse when his working days were done. This is one of the first objects of civilisation: it is a wise and noble task. On the other hand, it is equally foolish and hostile to progress to remove incentive at the same time that you remove the sanctions. We want to destroy the sanction and foster the incentive and not knock them both down together.

In short, there should be a solid floor on which everyone can put his feet, a floor of a reasonable protection from the hazards of life, a reasonable standard of life and comfort, but no ceiling; there should be free competition and greater rewards for those who exceed the average—in short, free competition upwards and not downwards.

It is now necessary to complete the right flank attack by a rather obvious and a rather hard statement. It is unfortunately a truism to say that the only sure way of increasing production is to work a little longer and not a little shorter hours. I particularly emphasise that when I say it is the only sure way, I do not say it is the only way. Again, if we were already working 55–60 hours a week an increase in hours would not bring any comparable increase in production, indeed it might well lead to a decrease. The truism is only of limited application, but on anything like a 44-hour or a 47-hour week, an increase of 5 per cent., or say 2¼ hours a week would just about fill the long-term shortage of labour from which we are now suffering. Let me give one example.

My own industry is on a 44-hour week of five days. Saturday morning is therefore overtime. Up till now, under the 47-hour week, the Saturday morning shift has been much under-manned. There is no other word I can use except under-manned, but it is above all the women who do not turn up on Saturday, and that for the very good reason that that is the day upon which they rely to do their shopping. However,

Saturday morning is now overtime at the rate of time and a quarter and time and a third, and if this results in the Saturday morning shift being better manned, then we might quite easily get a higher production, though at slightly higher cost, than we should for a five-day week of 47 hours when absenteeism was particularly prevalent on the half day.

Above all, this right flank attack must be directed at the psychology of the worker. He must feel that he is being fairly treated, he must feel that the employer's attack on organisation and industrial layout is a determined and successful attack. He must feel that the matter of his well-being has been cared for, he must feel that time and motion study is designed to reduce his fatigue and give him higher rewards for his day's work, but having said that he must be made to realise that you cannot take out of the common pool more than is put into it, that there is a standard of service to the community by the worker just as there must be by the employer, and lastly, of course, that more leisure, more to eat, more to wear, more warmth and comfort can only come from greater production and harder work.

I now sum up. Production depends first of all upon the supply of raw materials in the correct phase, so that all the components of a finished article reach the assembly line at the same time. I have tried to show that the distribution of raw materials cannot be efficiently organised unless the price mechanism is brought into play; it cannot perhaps be fully brought into play in the existing state of our oversea resources, but we can go a long way.

Secondly, our long-term problem is that we have more jobs to do than men and women to do them. It is therefore obvious that we have to increase the productivity per man-hour and per man-week. This in turn depends upon the three attacks, first upon industrial layout and greater mechanisation, secondly upon studying the reduction of fatigue for the worker, and thirdly, whilst continuing our task of removing the sanctions from the worker, that is the effects upon him of sickness and unemployment and penniless old age, to restore incentives.

Incentives should operate above a floor and that floor should be a reasonable standard of comfort. Above that floor, those who think or work or adventure above the average should have above the average reward. Above the floor there should be free competition. Psychologically we should aim at harder work bringing with it higher rewards, and the higher rewards should follow and not precede the harder work.

I conclude by saying that if you look coldly and rationally upon the problems which face our country to-day, if you look at the methods by which we are now handling these problems, you would I think go away with a feeling little short of despair.

No one should look at them only with reason. They should be looked upon with a deep faith in the British people. I am certainly animated by such a faith, but the people must be told the whole truth. They are entitled to good housekeeping and good management of their affairs. I suggest to you that in crisis or disaster, history has shown no people comparable to our own. I therefore express my belief that once more we can emerge successfully, and that once more victory over the impalpable enemies and over national bankruptcy, can be achieved in peace as we achieved victory over our human enemies in war.

The time is short and the truth has not yet been made clear. The remedies lie to our own hands: "The fault, dear Brutus, lies not in our stars, but in ourselves, that we are underlings".

DISCUSSION

THE CHAIRMAN: I do not know how you feel about it, but, speaking for myself, I can say that I have rarely heard so good a paper, and my faith in the British people is again renewed, because I believe fully what Mr. Lyttelton has said.

Some of you may like to ask questions, and I am sure that Mr. Lyttelton will regard it as a pleasure to answer them.

Mr. EDWIN P. HUBBARD: There is one point on which I disagree with Mr. Lyttelton. I agree, of course, that incentive should be maintained, but I think that in the present state of human affairs there should be also some measure of sanction, whereas Mr. Lyttelton said that we should remove sanctions.

Mr. LYTTELTON: Quite frankly, I disagree with Mr. Hubbard. I do not believe in getting a proper distribution of labour by the creation of a surplus of labour, and through the operation of unemployment, which is the sanction that I have in mind particularly. It is very often said by reactionary members of the community (Mr. Hubbard does not belong to that section of the community, because he agrees with me about incentives) that labour cannot be properly distributed unless there is a surplus of labour and a fear of unemployment. I regard that as a very bad state of affairs. We have to learn how to distribute our labour, even when there is a surplus of work to be done and a shortage of labour. I do not want to see the stick brought back.

Mr. WILFRED CAMPBELL-CRAIG: Is it not a fact that people are not working so hard now because there are so few things for them to buy with their money? Is that not hampering production?

Mr. LYTTELTON: As far as production is concerned, I think it is true to say that a year ago production per man-week was about 25 per cent. below what it was at the peak of the war. It is unfortunately impossible to take out any statistics now, because production is hampered by the shutting off of power, by the lack of solid fuel, by bottle-necks in raw materials and components and so forth, but I have the impression that the output per man-week has improved. It is still, however, considerably below that which was reached during the war. That applies all through the industrial system. Even the sickness rate tends to increase in the present conditions of lack of incentive. A man sneezes at home in the morning, and his wife says: "You have got influenza and you must go to bed", whereas if she wanted to buy a new hat or keep up the instalments on the refrigerator she would say: "That is nothing; take an Aspro and get out on the shift". I think it would be incorrect to say that we are getting a full week's work out of the present labour force, apart altogether from the interruptions which are caused by materials being out of phase.

Mr. SIDNEY T. LAUGHTON: Is not it a fact that the shortage of labour is caused by the fact that a large number of people spent six or seven years in the Services and have not been trained and that, at the other end of the line, others are getting old and retiring; also by the fact that many people who could be useful in ordinary commerce are being employed non-productively in the various branches of the Civil Service?

Mr. LYTTELTON: Broadly speaking, we have six years' pent-up demand, especially for plant and machinery; we have the casualties of the war, six years' loss of technical training, and so forth, and a static feeling on the part of the population at the moment; there is no buoyancy there. The combination of all those factors, coupled with great physical destruction by the enemy, causes a shortage of labour which I do not think will be overcome, even if everything is well managed, in less than seven, eight or ten years.

Mr. E. J. B. LLOYD: Mr. Lyttelton touched on the question of small-scale production as compared with large-scale production, and I should like to ask how far our productive machinery is properly organised and planned. Is there any advantage in artificially closing down the smaller workshops and trying to encourage bigger units? Is the fact

that we have so many small workshops a handicap to us in face of the large factories in America, and would it be a good thing if it were possible to amalgamate these small units into bigger units?

Mr. LYTTELTON: I do not think so. I think there is a great flexibility in the small firms. I believe I am right in saying that more than half the operatives in industry in this country are employed by firms with less than 500 employees on their books. The amount of jobbing work, and so on, which is done by the small firms is of great advantage to industry as a whole, but, of course, there is in the lower half of the small firms a great waste of skilled labour. I have seen ordinary screws being made by a skilled man, whereas an automatic machine would turn them out rapidly in thousands. That is the sort of waste which we have to avoid, and it does tend to occur when a retired foreman, for instance, sets up on his own without the capital required to purchase modern tools. That is a danger, but I think we should leave the small firms as they are and not attempt to form them into big units. I think the tendency of industry is to turn away from factories with ten, twelve or twenty thousand workers to factories with a comparatively small number, ranging from two to four thousand. Personally I believe that about four thousand should be the limit in many cases.

Mr. WILFRED CAMPBELL-CRAIG: Do the large trade associations that control prices cut down production or help production?

Mr. LYTTELTON: I will give you a general answer, because the position of the trade association differs immensely from one industry to another. I think that any arrangement which is designed to keep production lower than it would otherwise be, in order to maintain a high price, is poisonous to our economic future, and there is no doubt that, under the fear of bankruptcy, such practices have been fairly prevalent. They are akin to the "ca' canny" and "go slow" policies of labour to avoid unemployment by spreading a job over as many people as possible for as long a time as possible. These practices are now quite out of date, and we must be careful to see that the trade associations do not keep up the price and reduce production. I do not think that is happening very much now, because I believe the preoccupation of every industrialist is how to turn the stuff out, and when a salesman appears in the board room with a broad smile on his face he is usually told to go out and not come back, because his smile generally indicates that he has a large order, which it is very difficult to get into the production programme.

Mr. R. CAMPBELL FEATHER: Mr. Lyttelton says it is necessary that employers should avoid succumbing to frustration. Would he agree that the workers also are feeling a sense of frustration? They had hoped that two years after the end of the war they would be getting more food, more clothes, and so on, and now they find that they cannot get them. The policy of the present Government seems to be not to try to expand production but to bring in more rationing and controls and to draft more potential workers into non-productive occupations.

Mr. LYTTELTON: I am not sure that there is not a slight political tinge to that question!

When I refer to the restoration of incentives I naturally include the ability of the work-people to buy things. They are certainly extremely frustrated now, first because they cannot buy things and, secondly, because the bottle-necks are making it impossible for them to obey the exhortations to work hard and produce more. I have long ago in my own affairs stopped all such exhortations. If a machinist has so many castings to machine during the day and they are divided into half, what is the good of driving him to work twice as hard? I think we want to get things back into the shops. The controls keep on increasing because the amount of money which is pumped into the system is increasing at an alarming rate, and the more you increase the money the more you must clamp down on the exiguous supply of goods, in order to avoid one getting at the other.

Mr. HUBBARD: If coal production diminishes under nationalisation, would not it be right and proper, in the national interest, to return to private enterprise, which proved its value in the past?

Mr. LYTTELTON: I can only say that I do not believe that the man who has just been

given Government securities for his holding in coal production or in anthracite production in South Wales would be very much attracted even by a prospectus put out by the distinguished bankers that I see amongst the audience. It is quite impracticable to suggest what would happen if he were so attracted, because he will not be. I think what you have probably to do is to take the nationalised mines as you find them and try to loosen up the whole thing as far as possible and get a greater sense of competition into the business. To put it back under private enterprise would mean that private people would have to risk their money in coal mining, and, to be quite frank, I do not believe they would.

Mr. O. RENDELL: I was very interested in Mr. Lyttelton's reference to the health and comfort of the workers as a factor in increased production. About two years ago I attended a meeting here at which Mr. Wilson, the Art Director of the British Colour Council, read a paper on colour. I asked him to come to our factory in the north and advise us on the painting of one of the departments there. He advised us to paint it in various light colours, and we had it painted according to his design, with the result that in the last twelve months the production of the department has increased by approximately 10 per cent.

Mr. J. G. BARBER, A.M.I.MECH.E.: I think it would be interesting to hear Mr. Lyttelton's views on the difference between the incentive which drives a man to work who is paid by results and the incentive which drives a man to work who is not paid by results.

Mr. LYTTELTON: Payment by results is a form of incentive which is frequently adopted, but it is not possible to pay everybody by results; for instance, the sampler or the testing engineer cannot be paid by results, and the incentive in such cases must be that the wages the man receives can be turned into something that he wants to get. If possible, he should also have some interest in the profits of the business as a whole, but that has a very limited application. I mean by "incentive" largely payments by results and the introduction of piece-rates wherever possible.

Mr. G. J. MOSES: In Mr. Lyttelton's opinion, would co-partnership and profit-sharing schemes act as an incentive to workers and in some industries present an alternative to nationalisation?

Mr. LYTTELTON: I think that co-partnership and profit-sharing, in the technical sense of the terms, can be applied to only a very small number of businesses, such as businesses in which the ratio of output to labour force is very high and, in particular, businesses in which the profits are stable. The employer generally regards profit-sharing and co-partnership as a means of raising the basic cost and the worker generally regards them as a means of keeping down the basic wage, so they are unpopular on both sides of industry. Again, if the worker's share in the profits is made fairly large, the money which he earns in that way gets into the family budget, and when there are no profits the worker is in a difficulty and so is the employer in his relations with the worker. Those objections do not apply to a stable type of business, especially one which depends on the right to charge a statutory rate, such as a gas company, where profit-sharing works very well, nor do they apply to a publishing company, such as Messrs. Macmillan, where the value of the output is out of all relation to the number of people that are employed and the business is very stable and matures like old port every year. In the sort of business in which I am engaged, however, to give every employee £12 a year at Christmas would cost us about £700,000, which would be more than the shareholders are now receiving, and I do not believe it would add materially to the incentive at present given to our people to carry on their work.

THE CHAIRMAN: I am sure a member of the audience would like to move a vote of thanks to Mr. Lyttelton. I should like personally to thank him for a magnificent address. He spoke plainly and frankly and did not try to evade anything, and I think he provides an answer to the question which has been in the newspapers a great deal lately, namely: Who is there in England who is capable of directing the activities of all the companies carrying on business in the kingdom? Sir Stafford Cripps was looking for someone to do that, and I suggest that we have that person with us this afternoon.

Mr. Lyttelton referred to something that I said to him seven years ago. He did not tell you what it was. I heard him make a speech which was very poor, and I told him so. I said: "With your brain, your knowledge and your skill, you ought to speak every day, because if you practise speaking you will become a very great speaker". He justified my advice this afternoon and I congratulate him.

Mr. WILFRED CAMPBELL-CRAIG: I should like to propose a vote of thanks to Mr. Lyttelton. I regard it as a great privilege to have heard him speak on the subject of production, and I can only say that his address this afternoon was on a par with those which I have heard from Mr. Lewis C. Ord, a well-known and very great man in industry. I am sure we are all very grateful to Mr. Lyttelton for his paper and for the opportunity which we have had to put forward our views and to ask questions, especially at the present time, when information is so much needed on such subjects as production.

The motion was seconded.

THE CHAIRMAN: I have enjoyed the paper thoroughly. I think Mr. Lyttelton's approach was masterly, and he has justified to the full the confidence that I had in him seven years ago. The reason for that confidence is greater now than it was then. If I could tell you something of what Mr. Lyttelton did for this country during the war, you would realise how great a mind he has. I think Sir Edward Crowe will agree with me that the paper this afternoon has more than justified the confidence that we had in Mr. Lyttelton, and I for one shall go away from here with a greater confidence in the ability of this country to survive than I had when I came into this hall this afternoon. If there are enough men of Oliver Lyttelton's stamp in this country we shall survive, and if there are not, we shall not survive.

The vote of thanks was accorded with acclamation, and the meeting concluded with a vote of thanks to the Chairman.

WHITHER SOUTH AFRICA?

AN ECONOMIC APPROACH

By S. HERBERT FRANKEL, M.A., D.SC.(ECON.)

Professor of Colonial Economic Affairs, Nuffield College, Oxford

Dominions and Colonies Section jointly with the Royal African Society

Tuesday, March 18th, 1947

Mr. E. K. SCALLAN, *Acting High Commissioner for the Union of South Africa, in the Chair*

THE CHAIRMAN: I feel it an honour to be asked to preside at this meeting to-day, especially as the address is to be given by such a distinguished son of South Africa as Dr. Frankel. As you know, Dr. Frankel is now Professor of Colonial Economics at the Nuffield College at Oxford, a post which he has occupied since about October of last year. Prior to that he was Professor of Economics at the University of the Witwatersrand in Johannesburg. He is one of our best-known economists, and I am sure we are going to listen to an extremely interesting address.

Professor FRANKEL then read the following paper:

I wish to thank you, Mr. Chairman, for doing me the honour of presiding to-day, when I know how busy you are with your numerous official duties. I wish also to express my thanks to the Royal Society of Arts and the Royal African Society, and in particular to Sir Harry Lindsay, for extending an invitation to me to address

this joint meeting. I greatly appreciate the opportunity of doing so, as for a long time I have watched the work of both Societies with great interest and have profited greatly therefrom.

The title of this address may mislead some of my listeners to expect me to indulge in prophecy. That is not the function of the economist, who, indeed, is popularly held to be more successful in explaining the inevitability of an event after it has occurred, than in forecasting its happening. The title I have chosen is based on the old proverb " Know who you are, where you are from, and where you are going". This proverb could be applied more frequently than it is, not only to persons but to the communities in which they live.

It is my object to draw attention to some of the fundamental economic forces which have fashioned modern South Africa, to certain beliefs and institutions within the framework of which these forces have operated, and to certain decisions which now confront the people of South Africa in relation to the organisation of their economic activities in the future.

The history of South Africa might well be written around a series of miracles, if we can so designate those remarkable occurrences which time and again have confounded current prognostications. It is an astonishing story.

For centuries this sub-continent repelled newcomers to its shores owing to its poverty-ridden aspect, its vast distances, its mountain ranges and lack of navigable rivers, which barred entry into the interior, its large areas of irregular rainfall and poor soils, its tropical diseases and agricultural pests, and its primitive indigenous peoples.

Until the last quarter of the nineteenth century the modern history of South Africa can be characterised as a struggle between the feudal eighteenth century society of the European immigrant population which penetrated from the South, and the pastoral pagan Bantu societies which migrated from the North, eventually to be overcome by the European colonists.

Who could have forecast a hundred years ago when this era was drawing to a dramatic close that the descendants of these diverse peoples, the one largely isolated from the European civilisation which it had left, the other meeting civilisation such as it had never known, would, within a hundred years build in this land of apparent poverty an economy equipped with every modern productive device? Indeed, that economy became strong enough to support the Union in two world wars to defend the civilisation of its European ancestors, and to emerge stronger from the conflict on both occasions.

The Impact of World Economy

The Industrial Revolution, and the World Economy, burst upon South Africa with the discovery of diamonds and, subsequently, of gold. These unforeseen events encouraged also the final stage of exploration of the African Continent as a whole. With these mineral discoveries there began, not only a new political, but also a new economic era—both for the patriarchal society of the white and for the tribal organisation of the black man. Very few prophecies have been so literally fulfilled as that of the then Colonial Secretary when, one day in 1867, he laid upon the table of the Cape House of Assembly one of the earliest diamonds discovered in South

Africa, and said, "Gentlemen, this is the rock on which the future success of South Africa will be built".

Diamond production proved the most effective means for obtaining surplus wealth with which to buy from abroad the capital instruments which South Africa so sorely required in order to open up its vast territories and to span them with modern means of communication. Moreover, it altered the manner in which Europe regarded the Cape Colony and established it in the eyes of the old world as a land of new possibilities in its own right instead of a somewhat troublesome half-way house to India. I have shown elsewhere[1] how the diamond pioneers, by establishing the financial nexus between Europe and Kimberley, enabled the South African Colonies to take full advantage of the second miraculous occurrence—the discovery of gold on the Witwatersrand in 1886, which led to a renewed wave of migration of capital and men from overseas to the economically barren interior.

Very few prophetic remarks as to the future role which gold-mining would play in the history of the country marked the opening of the richest goldfields in the world. Indeed, it is significant for reaching an understanding, not only of the past, but of the present, that ever since the discovery of gold on the Witwatersrand, both South African and overseas experts have often been more concerned with uttering warnings as to the not far distant decline of the industry, than with its real potentialities. It is possible that their fears resulted from the experience of the relatively short-lived gold-mining fields, of smaller extent, in California and Australia. Whatever the reason, it is probably due to this pessimism that economic policy in South Africa towards mining, taxation and labour questions has been unnecessarily affected by what might be described as "the mining-camp mentality", which is more concerned with what might happen when the mining camp will be deserted than with the conditions which have to be fulfilled in order that it should continue.

Gold has played the same part, relatively speaking, in the emergence of South Africa as an economic power, as coal did in Great Britain. It did not, it is true, feed the furnaces of its export industries. Gold itself was the export with which South Africa bought from abroad the capital and consumer goods which have established modern standards of life for its inhabitants. Gold-mining continues to occupy this pre-eminent, and so far irreplaceable, position in the South African economy.

With the end of the Boer War came the third wave of migration of men and capital. This was followed by a radical alteration in the technique of mining and metallurgy, which led to the opening of the deep-level gold mines, and the great boom in 1911. There followed the first World War, the rise in costs of mining, and the steady decline, with minor cyclical interruptions, until 1932. Thereafter, the series of changes which raised the world price of gold encouraged those boom conditions which, with very minor setbacks, lasted until the war, were fanned by the war economy, and have gained a new lease of life through the discovery of the remarkable new goldfields of the Orange Free State, and the large capital investments from abroad which they have stimulated.

Just as in the case of the first World War, so the second World War gave a great

[1] S. Herbert Frankel: "Capital Investment in Africa: Its Course and Effects." Oxford University Press, 1938.

impetus to the growth of manufacturing industry. Much of this expansion is again likely to prove permanent. Moreover, throughout this period of the modern economic history of the Union, agricultural production has drawn heavily on the capital resources made available through mining activity and has expanded in response to both export and growing home markets.

Natural Resources

In the face of this repeated beckoning of the finger of fate, who would dare to be a pessimist in regard to the natural resources of South Africa? What peoples have had greater opportunities showered upon them to assist them in their struggle with a new, and in many other respects, so difficult an environment? For consider also, that, in addition to gold and diamonds, and platinum, exploration has disclosed important base mineral resources, in particular, valuable low-cost coal and iron deposits, which have enabled the creation of an iron and steel industry and could, given those changes to which I shall refer later, lead to a wide complex of modern chemical and engineering industries based thereon.

Moreover, although it is usual to speak popularly of South Africa as a poor agricultural country, in fact it contains large areas suitable to specialised agricultural and pastural production for export, and other regions well able to produce by modern methods all of the food supplies of a much greater population than that which now inhabits the country. I doubt if any scientific observer, however pessimistic he might be inclined to be, would seriously argue that the Union has yet dealt as effectively as it could with its agricultural possibilities—or has faced up to the changes in customary methods which modern scientific agriculture demands.

Growth of the Natural Income

This cursory glance at the natural resources of the country can usefully be supplemented by a brief account of noteworthy changes in the National Income. If we take the periods 1911/12 to 1919/20 (Period 1), and 1922/23 to 1928/29 (Period 2), and 1932/33 to 1938/39 (Period 3), each of which, broadly speaking, commences a year after a depression or recession reached its lowest point (and each of which ends with the peak year of the subsequent boom), we get three comparable periods in the history of the Union which are of great interest. We find that the National Income at constant prices per head of the gainfully occupied population increased at an average annual rate of 1·4 per cent. in the first period, 2·5 per cent. in the second, and 5·3 per cent. in the third period. It will be noted that the rate of growth in the third period was more than double the corresponding rate of increase in the second period, and that the rate of growth in the second period had already been nearly double that which was achieved in the first. Indeed, the rate of expansion of the National Income in South Africa during the period of recovery after the 1932 depression has been one of the most rapid—if not the most rapid—in the world.

The net National Income produced (at current prices) was in 1911/12 about £131 millions. It reached nearly £395 millions for the year 1938/39 and the preliminary estimate for the year 1945/46 is £696 millions. If an attempt be made to allow for changes in the value of money, and for the increase in the occupied population, it is found that between 1911/12 and 1938/39 the real income (at constant

prices) per head of the total occupied population increased from £48·4 in 1911/12 to £77·3 in 1938/39, an increase of 59·7 per cent. Since 1938/39 the National Income at constant prices has continued to increase. At about £544 millions it was for 1945/1946 some 33 per cent. greater than before the war, but it is important to note that the rate of increase since 1941/42 has declined, and is in part fictitious because the rise in prices is not fully reflected in the cost of living index.

It is not possible for me, in the course of this brief address, to examine these changes in detail, and I have, therefore, to content myself with drawing attention to certain significant aspects only and to refer you elsewhere for a fuller discussion of these matters.[2]

Dependence on International Trade

First, I should like to draw attention to the fact that the Union is still greatly dependent on international trade, and obtains a large comparative advantage therefrom. One can say that the present equipment of South Africa in material capital (and in its location), and also in the nature of the skill of its inhabitants, is of a kind which, in one way or another is largely based on a system of production for export. About three persons out of eight in the working population are engaged either in the production or the transportation or the distribution of primary products for export. Thus, a rise or fall in employment in the export industries results in a more than proportionate rise or fall in employment in that part of the economy which produces goods and services for the home market. In other words, specialisation enables the Union to obtain a greater real National Income by exchanging its exports for imported commodities, which latter the country cannot produce in the same quantities and/or qualities, or at the same cost as it imports them. It is particularly noteworthy that of the total value of exports (excluding re-exports) in the period 1932/33 to 1938/39, the exports of minerals accounted for over 76 per cent. (of which over 71 per cent. were gold exports), whereas the average annual value of agricultural exports only accounted for about 20 per cent. This decline in the relative importance of agricultural exports, which has been almost continuous, is not likely to be arrested without those institutional changes to which I refer later.

Expansion of Manufacturing Industry

The extent of the expansion of manufacturing industry is shown by the remarkable increase in the net product of secondary industry. Twenty years ago the net product amounted to about £33 millions, in 1938/39 it had reached nearly £70 millions, and the preliminary estimate for 1945/46 is over £140 millions. This expansion has naturally been reflected in a large growth in the number of workers employed. From 124,000 in 1916/17 the number rose to 352,000 in 1938/39, to 390,228 in 1940/41, and to 471,000 in 1945. Nevertheless, notwithstanding the great expansion in manufacturing industry, the value of the exports produced by it remain very small.

[2] cf. S. Herbert Frankel (assisted by H. Herzfeld) "An Analysis of the Growth of the National Income of the Union in the Period of Prosperity before the War." South African Journal of Economics June, 1944, Vol. 12, No. 2 : and "Consumption, Investment and War Expenditure in Relation to the National Income." South African Journal of Economics, September, 1946, Vol. 14, No. 3.

The average annual value of manufactured exports was only just over £2,500,000 for the period 1932/33 to 1938/39, equivalent only to 2·5 per cent. of the Union's total exports. Even more important is the fact that 50 per cent. of all raw materials used in manufacturing industry had to be imported. Manufacturing industry itself was thus not able to supply more than an insignificant proportion of the exchange resources which it required for its productive activities and their expansion. These exchange resources had to be obtained from the sale of the Union's other exports.

The Union's experience in this connection has more than local significance. It throws into sharp relief the problems of industrialisation in other African territories and, indeed, in other backward areas of the world. It is sometimes hastily assumed that more effective employment in such territories can be provided by increased self-sufficiency and by the diversion of labour resources from industries producing for export to industries producing for the home market—in particular to secondary industries. The experience of the Union shows the fallacy of this belief and indicates the importance of maintaining exports, either in the form of additional manufactured products, or in the form of raw materials. If an economy has attained to certain income standards on the basis of appreciable advantages from international trade, then if these advantages should for any reason be reduced in the future, the National Income per head will fall, unless the structure of the economy can be so modified as to make good the loss of the real income from this source.

The Transformation of Subsistence Economy

The second point to which I would invite your attention is that notwithstanding the fortunate opportunities and developments to which I have referred, the overall picture which the Union's economy presents is still one of great poverty for the mass of its inhabitants. That poverty is difficult to express in statistical terms, but it is partly illustrated by the fact that the National Income (at 1938 prices) per head of the total population was still only about £50 in 1942/43—a figure which can, but only in the most general terms, be compared say, with that of £126·8 *per capita* for Great Britain in 1940/41 or £134·5 for New Zealand in 1937/38.

The general poverty of a large proportion of the people of the Union has been the main aspect of its economic life to which various private observers and official commissions have drawn attention. I suggest, however, that it is not the most significant conclusion which can be drawn from the relevant data. If we examine these figures we can detect certain tendencies of considerable importance. In the first place, it is clear that there has been a steady and very substantial rise in the average income per head since Union. Indeed, European income levels, taken separately, now reflect an absolute level, and a range in various income categories, which do not differ very greatly from those in Australia, or even Canada.

Non-European incomes are very much lower than European incomes. I suggest, however, that what is here most significant is that the incomes of the non-Europeans who have been drawn into the orbit of modern economy have increased so greatly as compared with the primitive subsistence standards of the tribal economy. This situation can be partly illustrated from the statistics of incomes earned in various employments. In 1942/43 there were 671,812 Africans employed in private manufacturing industry, in mining, and on the South African Railways and

Harbours. These earned total incomes[3] amounting to £39,220,000, or an average of £59·4 per head (as compared with an average of £39 per head in 1936). The number of Europeans employed in the same industries was 240,776 who obtained incomes totalling £80,252,000 or £333·3 per head.

The non-European incomes earned in these industries should, I think, be contrasted with the incomes of those occupied in subsistence production in the native areas. For these, rough calculations made in 1936, indicated an average income of about £3 per head per occupied person. It is probable that this figure in 1942/43 had reached about £5 or £6. While a large part of the non-European peoples in the Union is still confined to subsistence production yielding an extremely low standard of life comparable to that which continues to dominate the economy of most of Africa, it is probably true to say that the most characteristic feature of the Union's economic history during the last fifty years has been the tempo with which its indigenous peoples have been swept into, and have benefited from the modern economy.

This migration of the non-European population has been paralleled by the townward movement of a large part of the Union's European rural inhabitants. The consequence of this migration—in which the industrial revolution which has swept the Union continues to express itself—has been a substantial rise in income for most of those who have been caught up in the stream of economic change.

The Brake on Economic Advance

At first sight one might, on the basis of these trends be tempted to assume that the Union is merely repeating the economic experience of other societies subjected to the pressure of industrialisation, and, therefore, to forecast that the trend of average income per head is likely to be steadily upward, except for temporary setbacks due to world economic events and cyclical fluctuations. One might even be tempted to suggest that the rise of average income per head might be expected to be progressive owing to the increasing effectiveness with which this new-born industrial society gathered experience and obtained the economies of scale which have been so marked elsewhere. Unfortunately the industrial revolution in South Africa cannot be said to be proceeding automatically on these lines.

The tide of economic change which has swept South Africa has not created a mobile integrated economic society, but an economy which is composed of a peculiar series of non-competing income-creating groups. For the most part these groups are stratified horizontally, not in accordance with their actual or potential income-creating powers, but in accordance with the racial origin of their members. There is very little opportunity for the members of one group to promote themselves by their own efforts into membership of a higher income group.

In consequence of this system "skilled wage rates are high, both in relation to unskilled rates and in relation to the average-productivity of labour . . . . Whereas in the Western world the spread between the highest and lowest rates of wages is

[3] In Mining these figures include cash payments plus the value of food supplied to African workers, plus an allowance of £8 per head per year for housing. The South African Railways and Harbours returns include not only Africans but other non-Europeans. I am indebted for these calculations to Mr. H. Herzfeld of the University of the Witwatersrand.

usually about 30 per cent., and seldom more than 50 per cent., in the Union it is several hundred per cent. Skilled wages are on a level with those paid in Canada, whereas unskilled rates are on a par with those which prevail in Italy".[4] Whereas in 1940/41 the average remuneration per European employed in mining was £406·1, the corresponding figure for non-Europeans was £33·7. In manufacturing the figures were £261·0 and £60·0, and on the South African railways and harbours (including the airways) they were £251·4 and £45·5 respectively.

The economic structure of capitalist economy in South Africa is thus one of industrial caste. Whereas in non-caste societies men are promoted on the ladder of achievement, with appropriate allowances for minor non-economic factors, in South Africa the non-economic factors predominate and non-European workers can climb only a few rungs of the economic ladder to find the next section barred to their advance. Indeed, for the great mass of non-Europeans there is only one section of the ladder—that of unskilled labour, and that section has very few rungs of promotion.

The "Multi-Racial Team System"

For all practical purposes the laws, customs and institutions of the Union have the effect of bringing about a situation in which productive power is circumscribed by race. Economic activity is orgaanised on the basis of utilising workers in what can perhaps be described as a "multi-racial team system". Over large sections of economic enterprise those responsible can increase or decrease the size of the team, but they cannot easily vary its proportionate racial composition, or alter the scale of remuneration, or the nature of the tasks allotted to the different races of which the team is composed.

This peculiar system must not be regarded as absolutely rigid. As so frequently happens reality has played many tricks on those who cling to outworn conceptions of it. There are already considerable breaches in the system. Thus, while in 1925, there were 7,815 Europeans and 7,291 non-European women in factories, by 1945 the number of European women had risen to 32,043, and the number of non-European women to 21,251. Moreover, many semi-skilled operations are now performed at the same wages by workers of all races. These changes are important as showing a tendency for economic forces to dissolve the complex of the colour bar through the use of semi-skilled operatives.

They also indicate the formation of an occupational urban pattern along the lines of the Western world. These tendencies have, however, not progressed very far. "South African industries have been slow to make the fullest possible use of operative labour, which as a percentage of the total labour force is probably lower in the Union than in any other industrial country".[5] Broadly speaking, it remains true that no important South African industry is composed of a labour force graded in remuneration, skill or type of operation, wholly in accordance with the technical requirements of the industry or the capacity, output, efficiency or other objective criteria of the worker's productivity.

[4] Report No. 282 of the Board of Trade and Industries, "Investigation into the Manufacturing Industries in the Union of South Africa," First Interim Report, 1945, paragraph 412.

[5] Report No. 282 of the Board of Trade and Industries, paragraph 414.

The "multi-racial team system" of organising labour, as it might be called, is cumbersome in the extreme. It prevents the full development of latent income-creating power through specialisation, appropriate incentives, and individual economic mobility. These are essential for the full unfolding of the modern forces of industrialism, and the free development of personality on which alone they can be successfully based. It also disturbs the whole process of investment and the organisation of production in accordance with the most effective combination of capital and labour in the social interest. In consequence the field of industrial relations in the Union is a mass of inconsistencies and portrays avoidable surpluses of labour in some directions combined with shortages of the same or other types of labour in others. The general picture which emerges from this analysis is that of a society standing half-way between a feudal, or patriarchal organisation of effort on the one hand, and a modern open economic society on the other hand.

The emergence of the open economic society in the Union is, however, not only arrested by feudal or racial conceptions. Many of the existing barriers to the full unfolding of human effort take the form of restrictive practices by particular sections of workers. These thereby endeavour to protect themselves against, or to enrich themselves by preventing, economic changes which would be in the interests of the community as a whole. Such practices have much more in common with anti-social trade union, guild or other monopolistic restrictions of a kind well known in the economic history of, or existing practices in, Western Europe, than with racial prejudices which have resulted from the peculiar history of South Africa.

The Agenda of Objective Enquiry

In my opinion, the most important task now facing the Union is that of conducting an objective, independent, and expert enquiry into the following questions:—

(1) The effect of the present organisation of South Africa's economic life and labour on the productivity of the country.

(2) What alterations in existing forms of economic organisation would increase productivity, would raise the National Income, and, while at least maintaining existing high income standards, would raise those of the economically backward sections of the community.

(3) The effect on different races, classes of workers, and producers of any changes in economic organisation which may be found necessary or desirable.

(4) The practical measures which may be necessary to compensate or assist those races, classes of workers, and producers who may be detrimentally affected by economic changes required to raise the incomes of the under-developed sections of the community, while ensuring the maintenance of those higher incomes consonant with the aspirations of modern civilisation.

I would draw particular attention to the third and fourth points of what might be called an "Agenda of Objective Enquiry". They express the crucial economic problem of South Africa, which is faced with the unique task of raising the income standards of a numerically very much larger indigenous population while safe-guarding permanently its own European civilisation.

South Africa's Unique Problem

The Europeans in South Africa have throughout their history raised the standards

of the indigenous peoples, not through the work of temporary residents, who return after a while to a metropolitan country across the seas, but by constructing a new modern society in the midst, and with the help of the native peoples.

I believe that the unfolding economic history of South Africa may well contain constructive lessons of great importance for the modern world which is still excessively pre-occupied with the belief that the economic progress of under-developed societies must proceed on exclusive nationalistic lines.

The existence of a permanent European population, with high economic and cultural aspirations, has been the main cause of the relatively rapid economic advance of the indigenous peoples of South Africa. South Africa's problem is how to maintain, and increase, income standards all round instead of diluting those already achieved. This is a problem which can be solved neither by a stroke of a pen nor by the power of a sword. It is a problem of modifying old and creating new institutions, a problem of change and a problem of assistance to those detrimentally affected by the change, a problem of growth, and of social experimentation, rather than of dogmatic ideologies.

Economic Solidarity in a Multi-Racial Society

I am aware that there are some who might object to the assumptions on which this suggested enquiry is based. They might argue, especially, that in a multi-racial society there can be no general interest, but only the particular warring interests of its diverse racial groups. I disagree with this view for reasons which I cannot develop on this occasion, but which I have analysed elsewhere.[6] I will confine myself to stating that, in my view, there now exists an objective world economic solidarity, which is an inescapable reality and affects the lives of individuals in every community on the globe. Salvador de Madariaga has defined this objective aspect of world economic solidarity as "The interdependence between parts of a whole, without which the whole does not exist".[7] This world economic solidarity exists whether we like it or not, but there is a distinction between it and our subjective solidarity, the solidarity which we feel and create by an active attitude of our mind and soul. For the full realisation of the benefits of world economic solidarity the subjective appreciation of that solidarity must enter into the consciousness of the peoples of the world.

If it is true that the world as a whole is indeed an economic unity, and that perhaps nothing is more important for the future of all of us than a realisation of this truth, how much more justified is it to postulate an objective economic solidarity in any particular country, no matter how racially diverse may be the composition of its inhabitants, and to stress the necessity of a subjective realisation of this inescapable fact.

Indeed, there is no single part of the multi-racial society of South Africa which can even at this moment of great prosperity afford to be oblivious to the direction and rate of movement of the society as a whole.

[6] cf. S. Herbert Frankel, "World Economic Solidarity" and "World Economic Welfare," South African Journal of Economics, September, 1942, and September, 1943, Vols. 10 and 11, respectively.

[7] Salvador de Madariaga, "Theory and Practice in International Relations," page 5. (Oxford University Press, 1937.)

Opportunities and Dangers

As I see the position, the Union now stands before greater opportunities than ever before in her history. The constructive forces of industrialism have advanced further within her borders than in any other territory in Africa. A large, new generation of men and women is emerging from her schools and universities, equipped as never before, to grapple with South African problems. Her technicians and scientists, industrialists and business men, are called to new tasks beyond the borders of the Union and have already played a vital rôle, not only in the development of mining, agriculture, commerce and industry in other African territories, but also in grappling with the common problems of the environment of this rapidly unfolding continent. Moreover, in the last twenty-five years great advances have been made in dealing with the educational and sociological problems of its diverse peoples, and a larger proportion of these than exists anywhere else in Africa has benefited from contact with, and the discipline of, modern economic processes.

Yet notwithstanding the great economic tasks which the Union has already performed in developing its backward inhabitants, there is a very great danger that, intoxicated by the economic windfalls which the war and the new mining discoveries have unfolded, the dragging effects of the outworn system of labour organisation which still predominates will again be overlooked, and that consequently the country will be unable to realise those very opportunities which have encouraged the striking spirit of economic enterprise which now exists.

Already there are signs that the Union is in imminent danger of a permanent slowing down of the rate of growth, or even of a decline, of its productive powers, if the latter continue to be based on the institutional framework which governs the organisation of its working force.

Even immigration, which is still as essential as previously in the history of the Union, cannot in itself be relied upon to safeguard a continuous rate of economic expansion. Indeed, the flow of new immigrants is itself most seriously hampered by the "multi-racial team system" of labour organisation. This places a serious obstacle in the way of the employment of any but specialist immigrant workers and makes the numbers for whom employment can be found dependent not on their potentially diverse contributions, but on the places which can be found for them in the peculiar labour structure of the country.

The Strain on the Union's Economy

There are other significant signs that the Union cannot cope effectively with its growing economic responsibilities. For the real meaning of the desperate struggle against poverty of a large part of the urban proletariat, both black and white, is that, although its money income is higher than previously, its efforts have not yet been so organised as to yield the much higher living standards required by an urban industrial working force. The need to house, feed, clothe and educate this continuously growing urban population throws a tremendous strain on the Union's economy.

The strain in the towns is paralleled by a strain in the country, where agriculture is faced with the need for a radical change in its customary organisation of work and life if it is to keep pace with the new demands made upon it for food and raw

materials by an improving national standard of nutrition on the one hand, and by world changes in agricultural techniques on the other hand.

In mining, the strain is clearly visible in the steady rise in gold-mining costs, which come up against the ceiling of a fixed price for gold over which the Union has no influence. Apart from monetary factors, the basic cause of this rise in cost lies in the rigid labour structure of the industry. Indeed, as I see the position, the full development of the newly-discovered gold-fields may be most seriously hampered, and the life of many existing mines unnecessarily curtailed, if the situation is not dealt with on its economic merits. The same strain on labour resources is shown in manufacturing industry by its inability to compete more effectively in world markets.

THE CHALLENGE

Here then are objective problems which challenge all classes and all sections in the Union. Their solution is as vital to employers as employees, to producers as to consumers, to one race as to another. They constitute the supreme challenge of South Africa's natural and human environment—a challenge which the Union must meet, and which cannot be escaped by taking merely momentary advantage of good fortune, which is as liable to obscure basic economic realities as misfortune will ruthlessly expose them in all their nakedness.

On the extent to which the Union succeeds in grappling with these problems will depend, not only such mundane matters as the rate of growth of the National Income, but the rôle which the Union will play in the rest of Africa, to which it is already imparting so much, and could impart so much more. On it will depend, finally, the contribution of the Union to the common problems of the Commonwealth and the World.

"China", wrote Adam Smith,[8] "seems to have been long stationary, and had probably long ago acquired that full complement of riches which is consistent with the nature of its laws and institutions. But this complement may be much inferior to what, with other laws and institutions, the nature of its soil, climate, and situation might admit of". In the same terms, it might be said that the fundamental need in the Union is for its people to awaken to the realisation of what " with other laws and institutions", the natural and human resources of their country might admit of.

In the last resort, the future of the Union thus depends upon the power of those with whom decision rests, to make not merely economic, but rather new moral decisions. In saying this I do not have in mind the application of a ready-made or absolute moral yard-stick—as if the problem involved were simply that of questioning the moral worth of the people of the Union. That is too simple, even if at times a very popular method of escaping from reality. The men and women of South Africa on whom the responsibility for decision in these questions now rests are no better and no worse than other men and women which compose the human family of nations and societies. Like these they are encompassed by fears and doubts—some peculiar to their own environment and history, others which they share with their fellow-men across the seas. Their problem, like those of other peoples, is to disentangle right from wrong, and to illumine the consequences of fear-impelled social action by the fearless light of reason based on social justice and greater

[8] Adam Smith : " The Wealth of Nations," Chapter IX.

human understanding. As Professor Ginsberg has recently written:[9] "In a changing and highly complex society the moral problems that arise require for their solution very often not so much fresh moral insight as a scientific analysis of the situation which might render possible the application of known principles . . . . Similarly, the problem of justice between nations or social classes is often intractable, not so much on account of the obscurity of the moral principles involved, but rather because of the difficulty of calculating in advance the consequences of the different lines of policy that are possible, especially the remote consequences. In any event, even if a divergence of moral principles be involved, the rational solution of a social conflict requires in addition to moral insight and the will to act on it an exact knowledge of the objective conditions of adjustment and thus a combination of ethics with physical and social science".

It is in this sense that I conclude that the future of South Africa depends mainly on objective enquiry, and a supreme will to act on the results thereof, into those fundamental problems of economic organisation which have been allowed to lie too long under the shadow of fear and doubt. I believe that if these problems are resolutely attacked the Union is likely to experience an era of development greater than any in her past, and that the peoples of South Africa have no reason to believe that they cannot cope with them nobly in the interests of the Union, of Africa, and of the World.

DISCUSSION

Dr. W. CULLEN: I spent the greater part of last year in South Africa and having lived there for many years I wish, as a member of the audience, to thank the author most sincerely for his very eloquent and able address. I do not think there is a single item in it on which I could cross swords with him. He has clothed in appropriate economic language thoughts and fears which have entered the minds of most of us who have lived in South Africa and know that country well. I must say that my stay in South Africa made me feel some apprehension with regard to the future, having regard to the problems which I saw everywhere.

The author mentioned that the farmers in South Africa have not made proper use of the recent scientific developments in agriculture. I believe that to be most painfully true, and I think that South Africa is commencing to realise it to-day, as it is taking steps to deal with erosion; but how pitifully small those steps are, and what meagre results are to be observed so far! I had to give evidence before a Technical Education Commission when I was in the country, and I said that, as far as country education was concerned, two of the most important things to inculcate in the youth of the country were, first, a desire to live on the farms and, secondly, a desire to know and to apply the most recent developments in practical agriculture, including the use of mechanical implements.

Mr. F. H. FLECK: How does the productivity of the industrial worker in South Africa, both European and non-European, compare with that of the industrial worker in the industrial countries of the world? Also, what is the rate of increase or decrease in European population as compared with that of the non-European population?

Dr. FRANKEL: With regard to the first question, it is rather difficult to make general comparisons. I should think that in certain forms of industry the efficiency of Europeans and non-Europeans in South Africa is less than the efficiency of workers in certain highly industrialised countries, but in the case of other industries it is probably greater.

[9] Morris Ginsberg: "Moral Progress." Being the Frazer Lecture delivered within the University of Glasgow, 1944, page 28. (Jackson, Son & Company, Glasgow)

I think it really depends on the length of time that the industry has been established and on its degree of development. In mining, for example, I should think the efficiency in the Union of South Africa is very high, whereas in certain newer industries it is probably lower. On the whole, I think that the team system of organisation results in a lower output per man taken over all the men in the team. I am afraid I cannot give a more detailed answer than that. In reply to the second question, the rate of increase of the European population in South Africa is slightly less than that of the non-European population. I have not the figures to hand at the moment.

Mr. H. S. L. POLAK: I think most of us have very much appreciated the objectivity of the address to which we have listened. Many of the points which the author has made have been in the minds of thoughtful liberal South Africans for a considerable time. I have noticed, for example, statements made by Mr. Hofmeyr, by the late Professor Hoernle and by the Director of the South African Institute of Race Relations, Mr. Rheinallt Jones, which go very much in the direction in which the author has gone this afternoon.

I feel that the greatest problem of South Africa is the fear complex, the Europeans' fear of the non-Europeans and the non-Europeans' fear of the Europeans. There is, for example, the fear of the Europeans that they will be supplanted by the non-Europeans, and, on the other hand, there is the fear of the non-Europeans that, whatever they may do, however they may attempt to advance economically, socially, or otherwise, obstacles will be placed in their way and they will not be able or be allowed to jump over them. That applies from the lowest to the highest. There are many trade unions in South Africa which will not admit non-Europeans to membership. Things of that kind become more and more irritating to people who are becoming increasingly self-conscious, and I think that what the author has sought to do is to suggest means by which an appeal may be made to enlightened self-interest. I know that religious people are always and quite naturally and properly anxious to insist upon moral standards, and we should be wrong if we did not emphasise them first and above all, but there are many people to whom the appeal of enlightened self-interest will come more easily and in the same ultimate direction. I think that what the author has suggested to-day is very much along those lines and therefore to be welcomed.

There are two other points that I should like to mention. The first is that, whilst the author laid emphasis upon the increase in incomes in South Africa, he did not, in my opinion, emphasise sufficiently the increase in the cost of living, which must have nullified it to a considerable extent.

Secondly, I would point out that on the geophysical plane South Africa is still on the way to and from India and, unless there are better relations established between India and South Africa, there will not be that security which South Africa needs in order to maintain and to improve the standards of life of all the communities in that multi-racial country.

Mr. J. P. FLETCHER: I should like to thank Dr. Frankel for the clear view that he has given of the new trend in South African life and thought. If I might put it into layman's language, I should say it is that the colour bar does not pay. The colour bar has very much troubled many of us in this country and in other parts of the world, as we look at the terrible difficulties of politics in the Union, as indeed in the whole of Africa, I hope it is true that, as the author has suggested, the political colour bars are being broken down in Africa and the economic needs of the Union are making some of them of no effect. The confusion, which we do not have to face in this country, we realise from a distance, but the Union has now come into world politics. The events in New York in connection with UNO have brought about quite a new situation. It is very fitting, I think, that in societies such as ours, in the calmness of distance from the actual political scene, we should have a clear statement put forward, as has been done this afternoon, which helps us to see the political disunity face to face with the economic unity of the Union and to see the economic unity not only within the Union but in relation to the whole world.

Therefore I am very hopeful of the suggestions which the author has made this afternoon, and I trust that in this country we shall do all that we can to strengthen the appeal to the leaders of the Union's political and social life, that they may see these great universal social factors and take courage for a more liberal policy that is in accordance with the facts

Mr. H. SWANZY: The speaker has given us an admirable comment on South Africa, clothed in appropriate economic language, but I should like to ask what are the prospects of putting these suggestions into effect. From my little theoretical knowledge I gather that many of his arguments have been put forward by various Commissions almost ever since the Union was founded. I want to know what are the steps which he envisages after the hypothetical objective inquiry into economic realities in South Africa has taken place. What steps by Government would be possible to explain in extremely clear language, the actual facts that are found in this inquiry? I presume that the average man and woman in the white minority in South Africa is probably not ready to follow the actual details of a full economic analysis. Would it be possible for any South African party to follow up a Commission of the kind suggested by explanations, which would inevitably be regarded on the hustings as propaganda, especially as most of the arguments that we have heard to-day have been to some extent concerned with the immediate self-interest of the urban and industrial workers, and not with the farm populations, who I understand still constitute a very large proportion of South African voters?

Dr. FRANKEL: I think the question is a very interesting one and appropriate at the present time, but I would adhere to what I have tried to convey, suitably clothed in economic language, by saying that the history of the Union shows that the Union has been able to make very considerable progress in solving the complicated problems which are under discussion. That progress has come about largely through the enlistment of an increasing number of persons who have been enlightened as to the true state of affairs. The educational policy among the native peoples, the social security measures, the increasing measures being taken for the welfare of the native peoples in their urban communities, the setting aside of land for them and many other measures would in the past have been regarded as just as impossible as some of the conclusions from the facts which an objective inquiry might unearth. The real problem in the Union is to break down the belief that this is only a Union question. It is not. The problem in the Union is not a problem which is confined to the Union: it is a problem of conflicting social structures and racial structures, a problem of communities of different races and interests and it mirrors a problem of the world.

There is only one way of dealing with these problems, and that is by enlightenment, to obviate the frictions based on ignorance. It is quite true that it would be foolish to assume that the recommendations of any inquiry should be immediately translated into political action, but that is not necessary. The pressures of change which are exerted politically are exerted with the full force which we have recently seen, but, even with the greatest political changes which might be brought about by international or national pressure, it is not possible to obviate the underlying objective realities of the South African situation, a situation which is paralleled outside South Africa in the relations between the western world and the eastern world. No amount of waving of pens and papers will alter these objective conditions. They will alter only slowly. I believe that what is most important is not speed in a certain direction, but choosing the right direction, and, in order to choose the right direction, one must be governed by reason rather than emotion.

Mr. P. G. HARRIS: The speaker suggested that it was necessary for the Union to maintain exports of secondary products. Would not it be better to encourage and increase the consumption of secondary products inside the country, and might not that possibly be done by a process of nationalisation of basic industries and increasing the rewards of the coloured people, thereby creating an increased demand for consumer goods? Also, could not it be done by the encouragement of modern and collective

farming, to reduce or keep down the prices of agricultural products, and also by encouraging African trade unions?

Dr. FRANKEL: The Union of South Africa is actually ahead of this country—or it was until very recently—in the matter of nationalisation, and I do not think that would help very much.

With regard to the export of manufactured products, unless the Union can produce the manufactured products at a lower net cost than the price at which it imports them to-day in exchange for exports there would be no advantage in its manufactured products being consumed inside the Union.

As far as the collectivisation of agriculture is concerned, that would depend very largely on the willingness of the people to be collectivised, and so far there has not been very much evidence of that.

Mr. PETER BLACKMAN: With regard to the point which has been made that the problems facing South Africa are world problems and the implication that they must be solved on a world scale, could the speaker indicate what he thinks is the right solution? He said, quite rightly, that in approaching this matter we must avoid emotion, but I should like to point out that, while avoiding emotion, we must also be careful not to avoid facts, and I think it is a fact that it is impossible to exploit the resources of any country, even a country like South Africa, without paying proper attention to the human needs of all sections of the population. I think it is a fact that in South Africa, as a result of certain policies there, at the present moment there are some half million —certainly some hundreds of thousands—of poor whites living at a level of human existence perhaps below and certainly not very much above that of the African population. Is not this a corollary of the policies pursued in South Africa? I should like to ask this question: How can the resources of a country like South Africa be properly exploited while a huge percentage of the population, namely, the black population, is debarred from effective co-operation?

Dr. FRANKEL: That is what I tried to indicate. I agree that it is not possible fully to exploit the resources of the Union without the full use of the potential powers of all the people in it, but what I meant by saying that we must get rid of emotion or try to curb our emotions was that in a multi-racial country it is not easy—in fact, it is extremely difficult—to bring about policies which, however good they may be in intention, will raise emotions and cause increasing tension and therefore be just as much a danger and as little to be desired by one section of the population as another.

I sincerely believe that the Union has made far greater progress in the last thirty years in solving these problems than any other country in the world, with the possible exception of one or two countries in South America. But we are not conscious in the Union—and certainly the world outside the Union is not conscious—of the extent of these developments. If you cast your minds back for twenty or thirty years and consider the conditions in which the native peoples lived then—and also a large portion of the white population—and then look at the opportunities and the work and the whole tempo of activity to-day, you will realise what a remarkable achievement there has been, but we are not very conscious of the facts which have brought it about, namely, the increasing opportunities for all sections of the population. The process can continue only if it is not upset by extraneous circumstances which confuse the fundamental issue. The problem is a world one, because on the stage of South Africa forces are meeting which to us seem purely South African, but are not, and therefore the solution which we may bring about in South Africa has more than local importance.

THE CHAIRMAN: I am sure that, having listened to the very eloquent words of Professor Frankel, you do not wish me to inflict a speech upon you. He has explained a very complex situation in a very clear and simple way, and I think he has put before you a view which we South Africans want the world to see, namely, that our very complex problems cannot be solved with a wave of the hand. There is an old Roman motto, *Festina lente*, and I think it applies very much in the case of South Africa. When a certain situation has been brought about by a high civilisation impacting upon a low

civilisation, the remedy can only come very slowly, but, as Professor Frankel has pointed out, in the case of South Africa, it is coming very surely.

I have great pleasure in moving a vote of thanks to Professor Frankel for his very able and interesting paper.

On the motion of Sir HARRY LINDSAY, a vote of thanks was accorded to the Chairman, which was carried with acclamation, and the meeting then terminated.

OBITUARY

THOMAS HENRY HOLLAND, 1868–1947

Sir Thomas Henry Holland, K.C.S.I., K.C.I.E., D.L., D.SC., LL.D., F.R.S., who died on 16th May, 1947, in his seventy-ninth year, had been a loyal supporter of the Royal Society of Arts for many years. He was a Vice-President at the time of his death and was Chairman of Council from 1925 to 1927. In the latter capacity he took a most intimate interest in all the Society's affairs, one important and lasting effect of which was the establishment of a superannuation scheme for the staff. It was also during his chairmanship that the Society's Fund for the Preservation of Ancient Cottages was raised. By the award to him in 1939 of the Albert Medal, one of the last to be presented by the late Duke of Connaught, the Society recognised his eminence as a geologist and mineralogist and paid tribute to his outstanding record of official and public service.

Sir Thomas Holland was educated at the Royal College of Science as a National Scholar. He was contemporary with another National Scholar, H. G. Wells, with whom he remained always on very intimate terms. He specialised in geology and mineralogy and his first post was at the University of Manchester where he was Berkeley Fellow. Joining the Indian Geological Service in 1890, he became Director in 1903. This, his first period of service in India, lasted for nineteen years and was scientifically, officially and socially unusually successful. Early in this period, he married the charming lady, Miss Frances Maud Chapman, daughter of the Deputy Commissioner in Oudh. Later, his scientific work gained for him the Fellowship of the Royal Society and he was made Knight Commander of the Order of the Indian Empire for his services.

In 1909, Sir Thomas returned to the University of Manchester as Professor of Geology and Mineralogy where he remained for nine years, although he was on leave for war service during the last two. While in Manchester, he served on the Royal Commission on Oil Fuel and Engines and for three years during the 1914–18 War was Major-Commandant of the Manchester University O.T.C.

The unusual distinction of being recalled to India came to Sir Thomas in 1916 to serve later for two years on the Governor-General's Council after being President of the Munitions Board. His work during the period of planning and reconstruction was of great importance and his report as Chairman of the Commission was the basis of notable and beneficial changes in the scientific services in India. This second period of distinguished service in and for India was recognised by his being made Knight Commander of the Order of the Star of India.

Returning to England at an age when many, after honourable service in India and notable service at home, would have been tempted to retire, Sir Thomas became Rector of the Imperial College of Science and Technology and held that

important post for seven years. The administrative part of his work at the College was heavy and important, and during his tenure of the rectorship the College became a constituent of the University of London. In 1929, Sir Thomas went to South Africa as President of the British Association (he had been President of the Geology Section in 1914 at the Australia Meeting) and his presidency was an unqualified success in every way. His address, delivered partly in Afrikaans, was memorable and enthusiastically received; it marked the opening of a most successful meeting due largely to the scientific eminence and social qualities of the President.

Further distinguished work as Principal and Vice-Chancellor of the University of Edinburgh for fifteen years began for Sir Thomas immediately after his return from South Africa. His previous extensive administrative experience made his tenure of this high office unique and Sir Thomas was particularly happy in his work in the northern capital. Not being Scottish (actually, Sir Thomas was a Cornishman and was linked with Canada through his father), he used to say that his university colleagues were unduly tolerant towards a misguided southerner; but it was his ability, his wit, his sense of humour, his rarely erring judgment and his untiring energy which in Scotland as in many other places made his work so outstanding. He was particularly proud of the distinction, extremely rare even for a Scotsman, of being an Hon. LL.D. of all four of the Scottish Universities. In spite of heavy administrative duties in Edinburgh, Sir Thomas still made time to hold such important offices in Science as President of the Geological Society and Vice-President of the Royal Society and to serve on various Departmental Committees. In recent months he was much occupied with work for the forthcoming International Geological Conference, of which he was President-Elect.

Sir Thomas Holland's eminence as a geologist and mineralogist was recognised by the Geological Society, which awarded him the Bigsby Medal, and by distinctions from many learned societies and universities in Great Britain and the Dominions. His distinction as a scientist and his success as an administrator in many high offices make a wonderfully interesting record. Truly, Sir Thomas Henry Holland was a great man who carried his greatness modestly. He was wise in counsel and a good and loyal friend with a profound sense of responsibility to all who worked with and under him. Many will treasure his memory and to have known him was a very great privilege.

CHARLES S. GIBSON.

GENERAL NOTE

THE BRITISH COLOUR COUNCIL.—On Thursday, May 1st, the President of the Board of Trade, the Right Hon. Sir Stafford Cripps, K.C., M.P., formally opened the new Centre of the British Colour Council at 13, Portman Square, London, W.1. The house, which is a fine example of the work of the architect Wyatt, was built in 1770 and has been decorated, equipped and furnished by Member Firms of the Council.

In addition to housing the Council's staff, the new Centre will provide a setting for exhibitions which will be held from time to time to illustrate different aspects of the work which the British Colour Council is doing for the co-ordination of colour and design. At present there is a display illustrating the use of Colour for Interior Decoration. Although the Centre is not open to the public in the ordinary way, Fellows of the Society who would like to view the premises and the exhibition will be admitted on application to the Enquiry Office at 13, Portman Square.

NOTES ON BOOKS

ODHAMS' DICTIONARY OF THE ENGLISH LANGUAGE. Edited by A. H. Smith, PH.D., D.LIT., and J. L. N. O'Loughlin, M.A. Odhams Press Ltd. 1946. 12*s.* 6*d.*

"In 1755 we behold him to great advantage," wrote Boswell of our greatest lexicographer; "his degree of Master of Arts conferred upon him, his Dictionary published, his correspondence animated, his benevolence exercised."

The latest dictionary, a stout, handsomely bound and moderately priced volume of 1,280 pages, is a work of scholarship whose compilers may well, after eight years' labour, share Johnson's satisfaction.

The criteria that have guided the Editors are, in fact, the requisites of a popular dictionary: that it should be easy to consult, include all words in current use, provide accurate definitions, and employ a readily comprehensible and yet exact system of pronunciation. Most readers will acknowledge their success, while regretting that the publishers have been obliged to use a small type and pass a cheap-looking title-page which is less easily forgivable.

Included in the numerous Appendices are well-known names in Literature and Classical Mythology, and famous personalities in the spheres of Art and Music which (as in most lists of the kind) are intriguing mainly for the sake of the prominence given to some individuals and the unexpected omission of others. (Beardsley has five lines, those lesser giants Raphael and Botticelli two apiece, while Pryde, Nicholson and Conder are ignored!)

The line drawings in the text of the dictionary pleasantly break the pages, though again the consideration that guided their choice is a little difficult to understand, most people being sufficiently familiar with the appearance of a *bracket* but unlikely to recognise, shall we say, a *branchireme* when they meet one.

But some inconsistencies may be expected in a great undertaking of this nature, and the claims that are made on its behalf will no doubt be generally endorsed.

N. A. D. W.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, MAY 26..Universlty of London, School of Slavonic and East European Studies, W.C.1. 6 p.m. W. K. Matthews, "**Baltica—Phases of Estonian Poetry.**"

TUESDAY, MAY 27..University of London, School of Economics and Political Science, W.C.2. 5 p.m. Professor W. W. Rostow, "**The Shape of the British Economy in the Nineteenth Century.**"
6 p.m. Andrew Rothstein, "**Soviet Institutions—Finance.**"

WEDNESDAY, MAY 28..Fuel, Institute of, at the Geological Society, W.1. 2.30 p.m. Dr. E. A. Watson and Dr. J. S. Clarke, "**Combustion and Combustion Equipment for Aero Gas Turbines.**"

THURSDAY, MAY 29..Town and Country Planning Association, 28 King Street, W.C.2. 1.15 p.m. Paul S. Cadbury, "**The Herefordshire Survey.**"
University of London, Senate House, W.C.1. 5.30 p.m. E. P. Weller, "**Estate Management.**"
School of Slavonic and East European Studies, W.C.1. 6p.m. F. Friedenberg-Seeley, "**Historical Background of Russian Literature to 1881—Series II.**" (Lecture V.)

FRIDAY, MAY 30..Sound Recording Association, British, at the Royal Society of Arts, W.C.2. 7 p.m. D. O. Roe, "**Sound on Film and the Amateur.**"

MONDAY, JUNE 2..Geographical Society, Royal, S.W.7 8 p.m. John Grierson, "**Whaling in the Antarctic 1946-47.**"
Victoria Institute, 12 Queen Anne's Gate, S.W.1. 5.15 p.m. Sir Frederic Kenyon, G.B.E., "**Presidential Address.**"

TUESDAY, JUNE 3..University of London, at Imperial College of Science and Technology, S.W.7. 5.30 p.m. Professor Dr. W. G. Burgers, "**Metal Crystals.**" (Lecture I.)
School of Slavonic and East European Studies, W.C.1. 6 p.m. Andrew Rothstein, "**Soviet Institutions—Labour.**"

WEDNESDAY, JUNE 4..Electrical Engineers, Institution of, at 110 High Street, **Portsmouth.** 7 p.m. C. Lawton and V. H. Winson,(1) "**The Development and Design of Colonial Telecommunication Systems and Plant.**" (2) "**The General Planning and Organization of Colonial Telecommunication Systems.**"
Petroleum, Institute of, at the Royal Institution, W.1. 5.30 p.m. The Second Cadman Memorial Lecture will be delivered by Mr. Robert Price Russell.
University of London, at Imperial College of Science and Technology, S.W.7. 5.30 p.m. Professor Dr. W. G. Burgers, "**Metal Crystals.**" (Lecture II.)

THURSDAY, JUNE 5..Chemical Society, Burlington House, W.1. 7.30 p.m. (1) R. Royer and N. P. Buu-Hoi, "**Substitution-reactions of Triphenylethylene and related Compounds; a contribution to the problem of Synthetic Analogues of Progesterone.**" (2) Miss F. M. Hamer, R. J. Rathbone and Miss B. S. Winton, "**Some Trinuclear Cyanines Dyes. Part I.—The Synthesis of Neocyanines.**"
Goldsmiths' Company, E.C.2. 7 p.m. W. R. Cornelius and Miss Audrey Withers, "**Jewellery and Fashion.**"
Royal Society, W.1. 4.30 p.m. (1) Sir Thomas Merton Treas, "**On Interference Microscopy.**" (2) S. Tolansky and W. L. Wilcock, "**Interference Studies of Diamond Faces. A crossed fringe technique.**"
University of London, at Imperial College of Science and Technology, S.W.7. 5.30 p.m. Professor Dr. W. G. Burgers, "**Metal Crystals.**" (Lecture III.)
School of Slavonic and East European Studies, W.C.1. 6 p.m. F. Friedenberg-Seeley, "**Historical Background of Russian Literature to 1881—Series II.**" (Lecture VI.)

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4744 *FRIDAY, JUNE 6th,* 1947 Vol. xcv

ANNUAL GENERAL MEETING

The Council hereby give notice that the One-hundred-and-ninety-third Annual General Meeting, for the purpose of receiving the Council's Report, and the Financial Statements for 1946, and for the election of officers, will be held in accordance with the Bye-laws, on Wednesday, June 25th, at 3 p.m., at the Society's House.

(By Order of the Council),

KENNETH WILLIAM LUCKHURST,

Secretary.

ORDINARY MEETING

WEDNESDAY, JUNE 11TH, at 5 p.m. (*Selwyn Brinton Lecture*).—"INTERNATIONAL GOTHIC AND ITALIAN RENAISSANCE PAINTING". By Sir Kenneth Clark, K.C.B., Slade Professor of Fine Art, University of Oxford. Professor T. S. R. Boase, Director, Courtauld Institute of Fine Art, in the Chair. (Illustrated by lantern slides.)

ECONOMIC RECONSTRUCTION

(VII) DISTRIBUTION

By E. J. B. LLOYD, B.A., LL.B.

Director and Secretary, Lewis's Investment Trust, Ltd.

Sixteenth Ordinary Meeting, Wednesday, April 30th, 1947

The Right Hon. LORD WOOLTON, P.C., C.H., D.L., LL.D., *in the Chair*

THE CHAIRMAN: I am grateful to the Society, of which I am proud to be a Fellow, for having asked me to take the Chair to-day. My business is not to deal with the subject of which Mr. Lloyd is a most competent exponent, but in the first place to introduce him to those of you who have not the privilege—that I have had—of having known him for many years. He comes to us in the first place as a student of economics, as a man who had the advantage of a complete educational background, who fortunately decided that it would be a good thing to go into commerce. He was for a period—and it was then that I first met him—the Secretary to the Retail Distributors' Association, a group of the larger retail stores of this country. There he looked after our welfare and guided us in the ways in which such a society should go. After a time I came to the conclusion that probably he was wasting much of his capacity in merely directing other people, and

I invited him then, to my great advantage, to join me in business. Since that time he has been the Secretary of the group of companies of which I am Chairman.

He is going to speak to us, as you know, on the problems of distribution. They are very important ones, and I see that many people here are practitioners in this subject.

I would but say this: public attention at the moment is much concerned with the problem of production, of persuading people to work harder on such sustenance as they are able to get to fortify themselves for their hard work, and by that means to help our national economy. There is, however, another side of life, to which I am glad that your Society is devoting some attention, and that is the problem of the comfort of life. The shopkeeper is a person who looks after the general comfort of the public. There are, I know, many people who think that they do it somewhat extravagantly. I must admit that, having a certain knowledge of the subject, I may not approach it with an unbiassed mind, and I am glad that Mr. Lloyd is going to talk to you about it. This, at any rate, surely is true: during the war years the women of the country have had to submit to many hardships, and I think that even at some additional expense they will be glad when distribution can be as effective as it was before the war: when no longer will they have to stand in queues in order to obtain their goods, and when indeed, obliging shopkeepers will once more say that they will be glad to deliver their commodities to people's homes, instead of making them come to the shops for them. When that time comes—if it ever does come in the lifetime of those of us who have gone grey in the head—I am certain that it will add to the general amenities of life in this country, and indeed those amenities at the present time are sadly lacking for all of us.

I have very great pleasure in introducing Mr. Lloyd and asking him to read his paper to you.

Mr. LLOYD then read the following paper:

I take it as a very great compliment that you have invited me to address you on Distribution, with perhaps the greatest living distributor in the Chair. I welcome the opportunity of taking part in this important series of lectures on Economic Reconstruction, and of addressing you to-night on the subject of Distribution, with special reference to "the angle of the consumer". For, although we are alleged to be a nation of shopkeepers, I find that outside those engaged in the trade itself there is lamentable ignorance and misunderstanding about the economics of distribution. This is doubtless because up to recent times there have been so few facts available on which to base any judgment. I particularly welcome the reference to the "consumer" about whom I hope to have much to say.

Like other matters dealt with in this series, distribution is a very large subject. In the first place, it covers the whole field of retail distribution, which, in turn, includes many types of retailers who differ from one another so much in degree that at first sight they appear to have little or nothing in common. It also includes wholesale distribution, which again is a function which is performed in a variety of different ways. In addition, there are other forms of middlemen who function in some trades, but not in all. Within the time at my disposal I clearly cannot cover the whole ground, and of the many possible approaches to the subject the one I would like to adopt is to direct my remarks to the Costs of Distribution, with special reference to retailing.

In order to do this I propose to take as my text certain verses from the chapter on Distribution, in the Report of the Cotton Working Party. In paragraph 3 of this chapter it is written: "Distributors have the extremely important function of interpreting and educating consumer demand so as to give the producers the chance

of achieving the most satisfactory results in economy and quality of production". Later on, in paragraph 6, the following sentence appears: "There is a strong feeling to-day among those engaged in this and other industries that the charges for wholesale and retail distribution take a disproportionate share of the price to the ultimate consumer, and that this matter deserves investigation as a question of national importance".

It then proceeds to give the build-up of the retail selling price for certain staple articles, such as a girl's dress, a man's pyjamas, a man's shirt, a pair of sheets, and a tablet of milk chocolate, showing in an interesting way how this final selling price is apportioned as between industrial costs and the charges for wholesale and retail distribution.

Finally, after a somewhat sketchy survey of the distributive process, and without producing much, if any, further argument, it makes, *ex cathedra*, the following rather astonishing pronouncement in its conclusion: "That charges for distribution have been taking a toll of the industry far larger than is consistent with the national interest". The use in this context of such a word as "toll" and of the qualification about "the national interest", turns this conclusion into a serious accusation against the distributive trades, and throws down a challenge which certainly must be met. I will do my best to meet it, and in particular, I will try and distinguish between the suggestion implicit in all such statements, that the retailer makes too much profit in return for the service he renders, and the more general expression of opinion, that retail distribution as a whole is wasteful in the form in which it exists to-day. As I shall have to quote many figures, I may perhaps be excused if I start by making a few elementary explanations.

In dealing with all trading figures, the usual retail practice is to express gross profit, expenses, and all other such relationships as a percentage of the selling price or turnover. Thus, the difference between the cost price of any given article and the price at which it is first offered for sale is described as the initial mark-up, and is expressed as a percentage—27½ per cent., 30 per cent., etc., on returns, *i.e.*, the final selling price. Moreover, as in the case of the industrial "cost plus" formula, the percentage mark-up remains constant whether the cost price of the article rises or falls. The aggregate of the selling prices actually realised for the day, week, month, or whatever the period may be, constitutes the turnover for that period, and to this total turnover the expense of running the business during the same period are also related. Finally, the value of the stock which takes as its starting point a physical stocktaking at the end of the previous half-year, is estimated week by week and eventually corrected by another physical stocktaking at the end of the current half-year. Most efficient businesses have a system by which the cumulative mark-up, as well as the cumulative expenses to date, both expressed as percentages to turnover, are taken out week by week or month by month as the half-year progresses. In this way, all the vital factors on which the health of the business depends are kept under constant supervision and control.

This practice in the retail trade of expressing their gross profits, etc., as a percentage of turnover is a source of constant confusion and misunderstanding to those accustomed to the more familiar "cost-plus" formula, where cost includes an allowance for overheads as well as the cost of the raw material and of transforming

it into the finished product. When presented with such tables as appear in the Cotton Working Party's Report, analysing the selling price of—say—a girl's dress, it is not uncommon to find otherwise quite intelligent people assuming that the retailer's 30 per cent. on returns represents *net* profit to him. If not in so many words, at any rate subconsciously, they compare this percentage with the 6, 8 or 10 per cent. on cost with which the manufacturer is generally satisfied, and it takes a long time to catch up with the effects of such a misconception.

Let us examine these percentages on returns quoted in the report, namely: 30 per cent. for a girl's dress; 25 per cent. for a pair of man's pyjamas; 27·5 per cent. for a man's shirt; and 25 per cent. for a pair of sheets. This, in fact, represents not the net but the gross profit realised by the retailer, and then only if the article in question actually sells at the price at which it is first offered, as opposed to being stolen, damaged, or for some other reason marked down in price. In other words, this percentage is really no more than the initial mark-up, and as every retailer knows, the aggregate gross profit realised at the end of the year is very different from the cumulative initial mark-up.

There are, as it happens, up-to-date statistics on this point, as a result of an investigation which the Board of Trade has recently carried out in connection with Cloth and Apparel Margins. Returns were rendered by a representative sample of 2,672 non-multiple cash retailers, large and small, and from all parts of the country, and you make take it that statistically the figures I am going to quote are authoritative and trustworthy. Moreover, the retailers concerned are all such as might have sold the articles referred to in the Cotton Working Party Report. In 1944, the gross margin, excluding discounts, actually realised by this sample of the retail trade was 26·62 per cent. on turnover and in 1945 26·08 per cent. In other words, there is a difference of up to 4 per cent. on turnover between the initial mark-up percentage and the gross profit actually realised, and you may take it that this wastage of up to 4 per cent. is normal trade experience.

This percentage figure is, as I have said, a gross margin, and from it has to be deducted the aggregate expenses of running the business, including remuneration. rent, rates, repairs, heating, lighting, etc. The average total expenses, excluding interest, for this group in 1944 was 21·28 per cent., and in 1945 20·57 per cent. of turnover. The net surplus, after deducting interest on borrowed money, but including cash discounts, was in 1944 6·49 per cent. on turnover and in 1945 6·8 per cent. These results are in line with pre-war figures for department stores alone, and may therefore be accepted as normal. It must always be a matter of opinion whether or not a given profit margin is excessive, but having regard to the essentially speculative nature of retailing, and to the margins which are accepted on a "cost-plus" basis as normal and proper in industry, the figures I have quoted cannot, in my view, be regarded by any stretch of language as exorbitant. Much less can they be described as extracting a toll from the public which is detrimental to the national interest.

However, even if you accept that the net surplus with which the retailer is left is not unduly high in relation to the commercial risk he runs, you may still properly ask whether the customary initial mark-up of—say—30 per cent. or 33⅓ per cent. on returns is not too high a price for the consumer to pay; whether with reasonable

skill in merchandising the recognised loss of 4 per cent. on returns to cover mark-downs, pilferage, and other unknown losses, could not be reduced; and whether finally it is really necessary for the expenses of retailing to cost as much as an average of 20·6 per cent. of turnover.

Let me deal first with the question of the 4 per cent., and in support of my contention that retailing is a highly speculative business let me quote again two extracts from the same chapter on distribution in the Cotton Working Party's report. The Committee is trying to determine who it is that ultimately decides the pattern which appears on the dress fabric, and points out that "the initial decisions on patterns are in practice made almost a year before the garment reaches the final consumer". It then rather regretfully comes to the conclusion that the starting point in settling any given design is the guess of the merchant convertor as to what the consumer is likely to want a year hence when she is offered by the retailer a selection of finished garments. The Committee somewhat naively decides that this is very much a trial and error process, and suggests as a remedy more research into consumer demand. It then quotes some evidence from a retail store executive to the effect that "if a retail store bought fifty novelties and twenty-six proved popular, the store was successful. If only twenty-four were popular the store had a bad season". Well, of course, this selection of design has to be very much of a hit or miss business. How can any amount of scientific research into consumer demand determine with certainty to-day what a woman is likely to want a year hence in the way of pattern or design? It is common experience that when presented with even a modest selection of the finished product from which to choose, a woman finds it difficult enough to make up her mind on the spot. How can any solemn committee of consumer research experts determine with precision here and now what she is going to want in a year's time?

Those who look at distribution from the outside are apt to over-simplify the problem, and to think of it all in terms of a tablet of Cadbury's milk chocolate. For merchandise of that nature, the retailer's contribution is admittedly little more than that of the automatic machine. But as soon as the elements of style, or fashion, or size, or novelty, enter into the merchandise no amount of research will eliminate that factor of risk which, of course, to a greater or lesser extent, must enter into every commercial transaction. Indeed, the common experience is that the more scientific the research, the more certain it is that the final answer will be wrong; and the really successful merchant is the person who happens to possess that mysterious combination of commercial qualities which is commonly known as "flair".

The risk incurred is of course, that the stock bought for purposes of trade will not find a purchaser at a profitable price, and as it is one which arises at each stage of production and distribution, the tendency (especially in a buyer's market) is for each link in the chain to try and reduce its stock losses to a minimum, and by buying as late as possible to transfer the risk to the link lower down the chain. Broadly speaking, the aim of the efficient retailer is to buy little and often, so that his capital investment in stock is always turning, and the goods he offers to the public are always fresh. Similarly, the wholesaler between the wars was tending to reduce the stocks he carried on his shelves to the extent that he was inclined more and more to postpone his orders to the manufacturer until he had himself received firm orders from his

retail customers. Thus, until some distributor was big enough and bold enough to take the initiative—and I will deal with this point later on in my paper—the tendency in the case of consumer goods was for this commercial risk to be pushed more and more on to the shoulders of the manufacturer, who very naturally complained that from neither the retailer nor the wholesaler was he receiving orders large enough to give him an economic run of production. Hence, the dominant note which it is not difficult to detect in all the Working Party reports, that somehow it is distribution which is the nigger in the woodpile and which is taking too large a slice out of the commercial melon in relation to the risks which it carries.

This constant effort on the part of the retailer to reduce the margin between initial mark-up and realised gross profit does not always take the form of trying to hand the baby over to the manufacturer. It accounted in fact for many of the significant developments which took place in retailing between the wars. Concentration on a wide variety of merchandise at one or two fixed selling prices; the offer of exceptional value in a relatively small range and selection of goods; and the development of bulk buying, so that the task of estimating future public demand in both quality and quantity could be entrusted to a few highly skilled and highly paid buyers: all these were marks of the effort which the retailer himself was always making to reduce the costs as well as the risks of distribution.

So much then for the speculative element in retailing which neither is, nor ever can be, wholly reduced to the level of an automatic machine selling Cadbury's milk chocolate.

What now of expenses? On this aspect of the problem the statistics collected for this same Board of Trade investigation throw an interesting light, in the sense that the average figures quoted above can be broken down for various sizes of business.

Weighted Aggregates of Results of Non-Multiple Cash Traders analysed by Turnover Groups

	Total Expenses	
	1944 %	1945 %
Up to £2,500	27·74	27·48
£2,501 to £5,000	22·05	21·94
£5,001 to £10,000	20·01	20·44
£10,001 to £25,000	20·69	20·19
£25,001 to £50,000	19·76	19·72
£50,001 to £100,000	19·84	18·96
£100,001 to £250,000	19·06	18·32
£250,001 to £500,000	19·58	18·51
Over £500,000	20·05	18·71
All turnover groups combined	21·28	20·57

The figures quoted are weighted aggregates of 1944 and 1945 results for nine different turnover groups, as well as for all the groups combined. Those for the smallest group may perhaps be discounted, in view of the possible inaccuracy of the returns rendered, but read as a whole the results disclose a remarkably smooth trend.

As one might expect they confirm that as a business increases in size, its operating cost expressed as a percentage of turnover, tends to fall. In other words, a larger business, which can spread its overheads over a bigger turnover can sell more cheaply than a smaller business, and this is in line with *a priori* economic principles. On the other hand, these results run counter to uninformed public opinion which is apt to regard the small shop as the cheapest form of distribution, and to look askance at the elaborate buildings and the high-power salesmanship of departmental stores. It is by no means accepted as axiomatic, either by the public or by Government departments, that the percentage operating costs of such *emporia* are almost invariably lower than those of their small competitors.

This brings me to the point of view of the consumer which must always be kept in the forefront of any discussion about distribution, and the thesis which I want to try and establish is that the real test to be applied to any system of distribution, is whether or not it can place the finished product in the hands of the consumer more cheaply than any other system. And this does not merely depend on whether the cost of operating its business is lower than that of its competitor. It does mean that if, as a result of its combined operations of buying and selling, it can place in the hands of the consumer, say, a first class tin kettle at 1*s.* as against the normal selling price of a comparable article of, say, 1*s.* 6*d.*, it is a good and highly efficient system of distribution. If, as is almost certain, it achieves at the same time great financial success, that is not in itself evidence that it is making exorbitant profits. I would go so far as to say that from the point of view of the consumer who is interested only in buying the best possible kettle for 1*s.*, it does not greatly matter how much profit it makes.

Before developing this argument I would like to say a word about the physical lay-out of distribution as we find it to-day. The pattern is naturally very far from uniform, as over a period of time different trades have created the sort of set-up which experience has shown to be best suited for handling their particular merchandise. In some trades there is the familiar chain of manufacturer, wholesaler and retailer; in others it is the custom for the manufacturer to sell direct to the retailer; in others again, importers and other middle men may increase the number of hands through which the article eventually passes before it reaches the ultimate consumer. Within the field of retail distribution itself there are all kinds of different types, *e.g.*, department stores, multiples, chain stores, co-operative societies, etc., all applying their own special technique, or catering for a particular class of customer. About the more highly organised types, much factual knowledge already exists, but about the field of retailing as a whole we shall have to wait for the results of the Census of Distribution before any reliable information is available. In the meantime, let it be admitted at once, that no totalitarian dictator, starting from scratch, would ever dream of creating such a system as it exists to-day. Nor would anyone who drives along the roads leading out of any of our great towns, and sees the dreary procession of derelict shop property on either side, attempt to deny that we have far too many shops. So much can be quite readily agreed, but what anybody can now do about it is not quite so easy to determine. Nor do I propose to-night to enter into the controversy. On the other hand, let it also be admitted by the same token that we almost certainly suffer from a superfluity of small producers and that if our totali-

tarian friend sets about the problem at all, he will have to tackle the small workshop as well as the small shop. Unfortunately when discussing small scale production or retailing, all sorts of factors other than purely economic considerations are apt to enter into the argument. Let it for the moment suffice to say that in all such discussions the one touchstone which ought to be applied is the point of view of the consumer.

Whether or not the small retailer performs a useful economic function, there is no doubt that after the T.U.C. he is by far the largest vested interest in the country. Moreover, in many trades, the very fact of his existence serves to create another vested interest—namely, the wholesaler. This presented no particular problem in peace time when there was reasonable freedom of enterprise to carry on one's business in the way one thought best. It can, however, assume considerable importance in times such as the present, when we are regimented, directed and controlled from the cradle to the grave. To the tidy Civil Service mind it is anathema that goods should be allowed to flow except in the well-grooved channel of manufacturer, wholesaler, retailer. Consequently, and whatever may have been the practice in the particular trade in peace time, the Civil Servant feels in duty bound to assume and make provision for the existence of a wholesaler somewhere in the chain of distribution. The result is that in all sorts of trades, in which they never existed before, wholesalers are springing up like mushrooms, and extracting a quite unnecessary middleman's rake-off at the expense of the ultimate consumer. Not only this, but manufacturers, who previously sold direct to the retailer, are legally obliged, against the natural rhythm of their trade to sell first to a wholesaler, so that he in turn can sell to the retailer; and whether or not the ultimate consumer happens to be forced to pay a higher price than she would otherwise have done is of secondary importance as long as the trade is organised on nice, tidy, Civil Service lines.

There have been many examples of this during the war. There was first the case of blankets. This is a trade in which it was the custom in peace time for the manufacturer to sell direct to the retail. Under war conditions a so-called Blanket Pool had to be created, which meant that all supplies were forced to go through wholesale channels, and at the expense of the consumer, an extra 15 per cent. had to be allowed for in the final selling price. There is also the case of the iniquitous Purchase Tax uplift. Purchase tax as you know is assessed on the wholesale value of the goods. If, however, you were a big enough buyer to go direct to the manufacturer, you were obliged to pay purchase tax not on the manufacturer's cost price, but on an uplifted figure which brought that price up to a fictitious wholesale level. All perfectly fair and proper if all you were concerned with was to prevent the big retailer getting any advantage over his smaller competitor, and were not concerned with the ultimate price which the consumer had to pay. However, the most grotesque example of this attitude of mind has occurred only within the last few months when the Board of Trade decided to allow the importation from India of £50,000 worth of footballs, £60,000 worth of cricket balls, and £20,000 worth of other sports equipment. The sports trade is one in which normally the wholesaler plays no part, the custom being for the manufacturer to sell his goods direct to the retailer. Sports equipment imported from India was usually handled by a representative of the

Indian exporter who sold either to the big retailers direct or to the manufacturers, who for this purpose acted as wholesalers; and he was paid by his Indian employer on a salary basis without adding anything to the cost of the goods in this country. When this transaction was under discussion, the Board of Trade satisfied themselves by dint of vast market research that cricket balls had, once upon a time, been sold through village saddlers. It was, therefore, imperative in their view that this quite trifling amount of imported merchandise should at some stage pass through a wholesaler, whatever may have been the pre-war set-up in the trade. At this point, the organised Indian importers and merchants in London sat up and took notice, and made representations to the Board of Trade that this parcel must be handled through a recognised Indian importer or merchant and he must have his proper commission of 10 per cent. Believe it or not, therefore, instead of the Indian representative selling direct to the large retailer who was perfectly well equipped to handle it, these goods have to pass first, through the importer or merchant at a cost of 10 per cent., then to the wholesaler at a cost of up to 33⅓ per cent., and finally, the wholesaler must sell to the retailer, who will add the same percentage margin as he would have done had he bought direct from the Indian exporter's representative; and it is absolutely "verboten" that any of these links in the chain should be left out.

Anyone who has had experience of a Government department can just imagine the intense cerebration, the mountainous files and the endless conferences which gave birth to this preposterous scheme, and you will observe that the hall-mark of it is the scrupulous effort to be fair to everyone but the consumer. One cannot help thinking that the same amount of mental and physical effort might have been better employed trying to produce more coal, or to combine a general increase in productivity with a reduction in unofficial strikes. It would be impossible to find a better illustration of the bad old kind of distribution against which the Cotton Working Party most properly inveighs, and in this instance, it is a Government department itself which has created it and imposed it upon a trade whose natural rhythm flows in entirely the opposite direction.

If this may be taken as a typical product of Government planning let me give you one or two examples of the results of enlightened private enterprise. They also happen to illustrate what I regard as the really constructive job which distribution can and should do; and if I happen to take these examples from the experience of my own organisation, let me hasten to say that I am sure other illustrations could be provided by many of our larger competitors.

You may remember that after World War 1, a permanent wave was a luxury reserved for the few and used to be supplied in small, but select, establishments at an average cost of five guineas. We set about the task of bringing this luxury within the reach of almost every woman who was interested in her personal appearance. By installing the most up-to-date equipment and tackling the job on a large scale, with skilled management and highly-trained personnel, we were able, in the early twenty's, to provide a first class permanent wave for 52*s.* 6*d.* The whole of the hairdressing trade was in an uproar, and prophesied that either they or we would soon be bankrupt, preferring that that catastrophe would overtake us and not them. In practice, what had once been a luxury for the few became almost a necessity for

all, and when the price of a wave eventually came down to 17*s*. 6*d*., the whole of the hairdressing trade flourished like the green bay tree.

To take another example of an entirely different kind. The popular size of carpet to fit the rooms of an ordinary suburban villa is 3 x 2½ yds. About the same period in the early twenties we were buying a chenille Axminster carpet of this size from Belgium to sell at 85*s*., and we rightly felt that it ought not to be beyond the wit of the British carpet trade to produce at least as good an article at a still more reasonable price. By dint of much hard planning and close collaboration with a well-known carpet manufacturer we were able to offer an even better British chenille Axminster to sell at 59*s*. 6*d*. Eventually, as the quantities we sold increased we were able to reduce the price still further to 49*s*. 6*d*. In this way we not only kept at home a trade which had previously been going abroad, but also provided our customers with a better article at almost half the price they had previously paid.

Finally, let me take my third example from a different field again. One of the features of trading between the wars was the greatly increased interest in home gardening. We set out to cater for that trade by applying the same principles as I have described above. As you know most of these supplies used to reach this country from Holland. So we found an enterprising Dutch grower whom we encouraged to develop, in East Anglia, a substantial horticultural industry in seeds, bulbs, rose trees, etc. From quite small beginnings we developed an annual trade which included some 15,000,000 British bulbs and at least 500,000 6*d*. rose trees, and it is quite certain that as a result of this team work between our buyer and this Dutch grower, many provincial households were able to enjoy their own home-grown roses who would never have been able to do so otherwise.

Such examples could be multiplied, but these will serve to tie up the threads of my argument. You will notice that in each example there was a public want which we, as retailers, were the first to recognise and then made it our business to satisfy. The initiative came from us and not from the supplier, and the constructive job of finding and stimulating the demand, and of developing the sources of supply to meet it, was done by us. And as a result of the creative work we did in these and other directions, there are now many suppliers in development areas, and other suppliers with names that are to-day household words, who received their first orders from us.

There is nothing here of the work which an automatic machine could do nor of the mechanical handing out over the counter of tablets of Cadbury's milk chocolate, which many people seem to think is the only function a distributor performs. In these examples, we were, to return to my original text, "interpreting consumer demand and giving producers the chance of achieving economy and quality in production". I have little to quarrel with the Working Party's definition of the distributors' function, subject always to this reservation that that constructive job which I have described can properly be done only by the big distributor. The small shop, either alone or in combination, cannot possibly assemble that volume of public demand which alone can bring any influence to bear on the manufacturer or direct his output along the right channels. We may, or may not, have too many small shops, but I am quite sure that there are not enough big ones, and that one of the surest ways of bringing down distributive costs is to have larger units. Only then it seems

to me are you going to get that broader and more constructive approach to the retailer's job.

That approach as I have said, consists primarily in the big retailer using his judgment as to what the consumer will find most useful and suitable, and then backing his judgment with his own money. But there are two other ways in which he performs a function of great importance to the consumer.

In the first place, his large purchasing power enables him to buy in the most competitive market. He brings into play the force of competition between manufacturers, and as he is not tied to any one supplier he is able to buy at what he deems to be the keenest price. Having done this, however, he also has to meet competition from other large retailers, and the effect of this double pressure exerted by competition is that prices are kept at their lowest level and the consumer's earnings and spendings go further. It should never be forgotten that while Trade Associations and Trade Unions protect the interests of employers and workers, it is the retailer, and in particular the large retail organisations, to which the consumer has to look for effective action in protecting his real wages. Perhaps I should exclude the Co-operatives from that generalisation as they seek by their dividend policy to turn themselves into a closed shop.

Secondly, and this is an aspect which I have no compunction in bringing to your notice at times like these, the large retailer, and in particular, the department store, has exercised great ingenuity in making shopping a pleasure and in providing many services which have relieved the housewives of strain and effort. Such attractions as the Christmas Toy Fair have brought light, colour and excitement into many a child's life, and are eagerly anticipated year after year. The cumulative effect of these contributions to national morale is by no means to be despised, and as the statistics I have quoted go to show, any additional cost, as reflected in the percentage operating costs is more than off-set by increased turnover.

I do not pretend that in carrying out what, in my view, can properly be regarded as a form of public service, we were moved by philanthropic considerations. We were, of course, prompted by the profit motive as any keen, alive, and efficient business should be. But, *pace* the Labour party, is there anything improper or immoral about that? In any event, the fact that our organisation has increased six- or seven-fold in twenty-five years does not suggest that the profit we were making on each transaction was in any way excessive. In this connection I would like you to reflect upon this point. If you were to ask any member of the public, or indeed, of this audience, who are the two or three retail organisations from which you could buy most cheaply, he, or she, would almost certainly name certain chain stores—and I hope the organisation to which I belong as well—who, at the end of the year, also contrive to make the best financial showing. It cannot be stressed too strongly and too often that to make large profits is by no means the same thing as to make an excessive profit on each transaction.

Unfortunately, the first and most violent impact of a rise in prices hits the customer when she goes to buy what she wants in a retail shop; and, as a result of that first unpleasant impression, nothing will convince her that the root cause of the rise in prices is not the excessive profit which the retailer himself is making. If the retailer is a large organisation and she happens to notice at the end of the year that it has

earned large profits, that conviction becomes even more deeply rooted. She will listen to no argument that the retail margin on almost every article in the shop has been controlled since the outbreak of war; and when, for example, it is remembered how exorbitant were the prices which retailers had to pay for shoddy, poor quality toys, that attitude of mind is excusable. What is not so excusable is that it is apparently shared by Government departments and others who ought to know better. For instance, the President of the Board of Trade has recently enforced a cut of roughly 2½ per cent. in retail margins on all cloth and apparel. There was no apparent justification for that cut on the face of the figures which had been collected to provide the basis for his judgment, and the real motives which lay behind his decision are still to seek. It has been suggested that the object was to make retailing so unprofitable that retailers would be forced to employ fewer staff, and that in consequence labour would be diverted from distribution to production. I believe the real truth of the matter to be that, having observed the excellent showing made by various retail balance sheets, the President developed what was nothing more accurate and precise than "a feeling in his bones", that retailers were making too much profit. In other words, he was not really concerned so much with the angle of the consumer, but allowed himself to be influenced by the facile generalisations about distribution of which the conclusion I have quoted from the Cotton Working Party's Report is a typical example.

I think I can speak for the retail trade when I say that these vague and unsupported statements about the inefficient, wasteful extravagance of distribution in this country are strongly resented. Such statements are easy to make, because there are no recognised standards by which to judge, but in so far as figures relating to departmental stores can be taken as typical, there was plenty of evidence before the war that that type of retailing was at least as efficiently conducted here as in any other country in the world. Operating costs were certainly far lower than in the United States, and at least as low as those of any other country in Europe.

So let us have no more of this mischievous propaganda, or if persisted in it should be supported by more evidence than the Cotton Working Party were able to produce before reaching their unproved conclusion.

Finally, let me leave this question with you. Which do you think has the more effective influence on the ultimate selling price to the consumer—and it is the consumer's angle which I want you to keep in front of you—the totalitarian cut of 2½ per cent. in retail margins brought about by the *diktat* of a President of the Board of Trade, or the constructive efforts and free enterprise of a large retail organisation which can reduce the price of an Axminster carpet from 85*s.* to 49*s.* 6*d.*? I hope the answer you give will not be quite the same as you might have given before you listened to this paper.

DISCUSSION

Mr. K. C. SINCLAIR: There is a question I would like to put to Mr. Lloyd in relation to his statement of the higher efficiency of larger groups of traders. It arises from the analysis of turnover groups which we have before us tonight. I know we cannot place too much reliance on trends, but it is rather interesting to note that in the percentage figures of total expenses, the trend of total expenses from the group (£2,501 to £5,000) falls, until we reach the group of (£100,001 to £250,000). The tendency thereafter, although small, is to rise again. It would be interesting to know if an analysis has been

made of groups over £500,000, and how far the expenses would rise or fall after that point. In other words, is there a group of optimum efficiency, not necessarily the largest group?

THE LECTURER: I think the answer to that question is, if you had seen the analysis of the individual items in the two larger groups, the element of depreciation was much larger than it had been in the smaller groups. If depreciation had been eliminated altogether, this trend would have continued downwards, as the figures show. The larger organisations seem to have allowed more for depreciation than the smaller ones did.

THE CHAIRMAN: I should still think there is an optimum, and if the overhead charges of rent and so on became too high, then you would get an increasing cost. The reason for that is the uneven distribution of shopping hours.

If there are no other questions from the audience, may I say on their behalf, Thank you, Mr. Lloyd.

I think those of us who are engaged in distribution owe him considerable gratitude for the trouble he has taken in producing this very authoritative paper. A lot of nonsense is talked on this subject of the cost of distribution by people either of envious mind or of political prejudice. I had to sit and listen to it yesterday afternoon in a discussion in the House of Lords about the Liverpool Cotton Exchange. A noble lord indicated that it was high time, in the interests of the consumer, that Government action was brought to bear on retail distribution, just as Government action had been brought to bear in the interests of somebody—I was not quite clear who—by closing down the Liverpool Cotton Exchange, the only international market that this country has left.

During the time when I was one of His Majesty's Ministers, I had some experience of having to fix prices: it is indeed true, as Mr. Lloyd has said, that the moment a Government intervenes, it has to take note of every section of trade, and I had no doubt about it, that those prices that I fixed—fixing as I did in order to prevent them going higher—did in fact result in preventing them going lower. After all, even the retailers are human beings, and when a Government comes along and says "these are the margins of profit which you are allowed to charge", the effect is that people charge those margins of profit. I believe one of the reasons why retailers at the present time are making adequate profits for the risks they are taking, and why those profits are in fact larger than they were before the Government intervened, is because at every stage people are being content to accept this Government sanction for these various margins, whereas in the old days we were so anxious to beat our competitors that there were no margins that were sacrosanct, and we indulged in the interesting exercise of seeing how cheaply we could sell things.

I wish those conditions would return. I am certain that when they do the margin of profit, particularly to the larger units to which Mr. Lloyd has referred, will drop, and once again people will enjoy the satisfaction of exercising their skill in distribution; once again they will feel that their competitors are on their heels and that, of course, is one of the things, apart from the reward, that makes the particular trade in which some of us in this room are engaged rather exciting. The skill to do it is there. While Mr. Lloyd mentioned a matter of 6 per cent. as being the amount of profit that was made, that is not what matters. What matters is how often you make it, and the skill consists in exercising such wisdom and such foresight in the choice of merchandise that it goes out almost before it comes in, and the oftener it does that, the better off you are at the end. We did indeed work before the war at very low margins of profit. For the instruction of my shareholders, and for my own amusement, I once worked out the average profit made on the selling of goods in the firms with which I was connected. It was 2½*d.* an article, and that included suites of furniture, women's furs, and all sorts of expensive goods; it also included those simple things that are in haberdashery departments, on which 2½*d.* would have been an extravagant amount of profit to get.

We can stand investigation in retailing. I personally have been urged—and I hope at a period when I had some influence in these matters I myself successfully urged—that there shall be at some future time a census of distribution. By that means the public

will at any rate know—and, what is more important, those who as either Ministers or Civil Servants control our lives, will know, what the real facts of the case are. If they are against us, then it will be for the public good that they should be dealt with. If, on the other hand, as I believe Mr. Lloyd has demonstrated, the retailers of this country are rendering service to the community at a reasonable reward for the risks that they run, then they might be protected from ill-informed criticism from people in high places.

On your behalf I beg to thank Mr. Lloyd for the trouble he has taken and for the most interesting paper he has given, and I ask you to pass that vote of thanks to him with acclamation.

Sir EDWARD CROWE, K.C.M.G.: Before we break up, I should like you all to join with me in a hearty vote of thanks to our Chairman to-day, Lord Woolton.

If a "Gallup poll" were taken of views as to which Minister of recent times has rendered wonderful service to the people of this country, I would say without any hesitation that Lord Woolton would be head of the poll. Just think of what women have to put up with now, and how much pleasanter life was in the days when Lord Woolton was Minister of Food. Lord Woolton has shown us to-day how much knowledge he has of this business of buying and selling. I should like on your behalf to thank him for the trouble he has gone to in coming here to-day and for the brilliant way in which he has presided over this meeting.

The vote of thanks was carried with acclamation and the meeting then terminated.

A CENTURY OF CHEMISTRY

By Sir HAROLD HARTLEY, K.C.V.O., M.C., F.R.S.

Twelfth Ordinary Meeting, Wednesday, February 19th, 1947

Joint Meeting with the Chemical Society to commemorate the centenary of its foundation

Sir THOMAS HOLLAND, K.C.S.I., K.C.I.E., D.SC., LL.D., F.R.S., *in the Chair*

THE CHAIRMAN: An interesting Minute in the proceedings of the Royal Society of Arts, dated 17th February, 1841, records a letter from Mr. Robert Warington asking permission "for a certain number of scientific men to meet together in the Committee Room (the room upstairs in this building) in order that they might consider the formation of a Society for Chemistry and Mineralogy".

That was 1841. In 1891 the Chemical Society attained its Jubilee, and, remembering that February was the month of its birth and this house was its maternity home and nursery, the Council invited their Fellows to meet here to celebrate the event, but by that time the Chemical Society had overgrown the capacity of this building, so they had to move elsewhere for the celebration.

The Centenary of the Society was due in 1941, but because of the war the celebrations had to be postponed and are being arranged for next July.

But the Council of the Chemical Society, recalling the month and the place of their Society's birth, have expressed a wish to have at least one of the special meetings in its original home. That is why the Fellows of the Royal Society of Arts have been permitted to share with those of the Chemical Society the privilege of hearing the address now to be given by Sir Harold Hartley.

Lord Bennett, our President, had intended himself to express our appreciation of the friendly attitude of the Chemical Society, but his doctor has advised him not to permit further interruptions of his course of cure; so the President has delegated to me, the senior of the Past Chairmen of Council, the pleasure of expressing on his behalf and on behalf of the Society, our cordial congratulations and good wishes.

When the twenty-five chemists met here in 1841, five of them were already active members of the Society of Arts, and to one of them, Arthur Aikin, both Societies were specially indebted*. He had been our Secretary for twenty-three years, had retired and been made a Life Member; then, when the new Society of Chemistry was formed, he was elected its first Treasurer, and afterwards, following Graham, its second President.

Aikin was a remarkable man of very wide intellectual range, a mineralogist of repute, one of the founders, and afterwards one of the secretaries of the Geological Society of London. It is through his influence, almost certainly, that the small organising committee proposed that the new Society should regard as its object the advancement not only of chemistry, but also of "those branches of science immediately connected with it". The original letter, as you will remember, suggested that it should include Chemistry and Mineralogy.

At that time, the forties of last century, we were going through the only period of depression in the history of the Society of Arts. Then, late in the 'forties, a reorganisation was undertaken, which included the adoption of a policy which was long advocated and partly practised by Aikin himself when Secretary. The Society undertook a quite new line of activities, becoming in effect the demonstration forum for the results obtained by the specialist bodies which had sprung up in great numbers about that time. The old Society of Arts had learned the wisdom of standing aside and handing over to specialist institutions activities in which it had previously been a pioneer—a very difficult process, but one that brought credit and success. Of all those for whom we have acted in this way as a sort of forum for demonstration—shall I call it a shop window ?—the Chemical Society has been amongst our best and closest friends.

Sir Harold Hartley in his brilliant career has joined two of the characteristics of the original Society—mineralogy and crystallography—at Oxford under Miers and afterwards with Sir William Cope. He has taken a special interest in the history of science, and I will now ask him to survey the developments to which the Chemical Society has made a real and a great contribution.

Sir HAROLD HARTLEY then read the following paper:

This evening Fellows of the Chemical Society have made a pilgrimage, not, it is true, a very long or hazardous one, although in this year of grace 1947 we shall return by torchlight, to John Street, Adelphi, to the Royal Society of Arts, the birthplace of our Society. We have come like the pilgrims of old, who made much longer journeys, in a spirit of piety to the place that holds such a high place in our memories, to pay our homage to the Society that gave us hospitality for our first meetings. It was on February 23rd, 1841, thanks to the initiative of Robert Warington and the kindness of his friend Arthur Aikin, formerly the Secretary of the Society of Arts, that twenty-five chemists, including Aikin, met in this building to consider founding a Chemical Society, and here its first regular meeting took place on March 30th, 1841.

The Society of Arts had been established for nearly a century, and its Secretary Aikin was a very remarkable man. He had been one of the founders of the Geological Society, but his abiding enthusiasm was for chemistry, thanks to his early friendship with Priestley, and he became the first Treasurer of the Chemical Society and its second President. So we started life with a close personal link between us.

*A link between the Royal Society of Arts and the Chemical Society, strangely parallel to that formed by Aikin, exists at the present time in the person of Dr. D. C. Martin, who is not only a Fellow of both Societies but has been successively Assistant Secretary of the Royal Society of Arts and Secretary of the Chemical Society. He held the latter office at the time of the meeting recorded here (at which, of course, he was present), but is now Assistant Secretary to the Royal Society.—(Ed.)

However the fledgling Society soon wanted to try its wings, and in six months it left the nest to go to the Westminster Literary and Scientific Institution in Leicester Square. There was some fear too that chemical experiments might not be welcomed in these august precincts. But migration was found to have its drawbacks; oddly enough there were difficulties about heating; they missed this warm nest, and in 1842 the Society was back in John Street, where it enjoyed the hospitality of the Society of Arts at the modest rent of £25 a year until 1849. The Annual Reports reveal the general satisfaction of the members with this arrangement, and indeed in 1844 the Council reported "that the arrangement . . . continues to be satisfactory to both parties, and especially to ourselves, as we have not only acquired a convenient habitation, but have avoided the expenses included in the word establishment so often ruinous to young Societies". Happy indeed is the institution that has no overheads!

But by 1849, when the Society got its Charter, it had outgrown the limits of your kind hospitality, and needed rooms for its library and collections, which it found in the Strand. And so ended this happy connection between us, for which the Chemical Society will always be most grateful.

This year in July the Chemical Society is celebrating, somewhat belatedly, its centenary, and tonight we come here to commemorate its first meeting in the building where it took place. It is my privilege, in this joint meeting, to try and sketch the achievements not of the Chemical Society, for that is the task of the President, but the achievements of our science since 1841—what it has done, with the help of its sister sciences, to give man control over the materials on which his well-being depends, and to throw light on the complexities of living matter.

Chemistry in 1790–1840

1841—just over half a century since Lavoisier had given chemistry its modern form in his great Treatise of 1789, his autobiography of one of the simplest and most decisive revolutions science has known. Lavoisier applied to chemistry not only the balance but, being skilled in affairs, the method of the balance sheet. The idea of the chemical equation dominated his mind, and his first chemical equation dealt, as the Bible tells us, with one of the earliest and one of the most significant chemical reactions known to man. It runs:

Grape juice = alcohol + carbon dioxide.

We owe to Lavoisier the first clear distinction between physical and chemical change. With La Place he laid the foundations of thermochemistry. We owe to him the idea of organic combustions by which he was the first to determine the quantitative composition of the products of living processes. When he was guillotined in 1794 he was setting his course towards the Atlantis of biochemistry.

After Lavoisier in 1808 came Dalton with his Atomic Theory. It was one of those flashes of genius that crystallises an idea that had been floating in men's minds for centuries, and gives it the simple concrete form that makes it a powerful instrument in the hands of mankind. Lavoisier's analyses and his nomenclature could then be translated into atomic formulæ, the chemist's shorthand.

The next landmark was Davy's verification of Lavoisier's prediction of the existence of the alkali metals; their isolation by electrolysis laid the foundation of

electrochemistry and of the association of chemical affinity with electrical charges. Davy also redressed the balance of Lavoisier's over-estimate of the central position of oxygen by showing that the essential element in an acid is hydrogen and not oxygen.

And then, just as chemistry was attracting more and more attention and new chemical facts were being discovered so rapidly, came the Swede, Berzelius—the most massive figure in the whole of its history. In a few years he determined single-handed with amazing skill and sagacity the atomic weight of every known element and the composition of many compounds, thus giving added reality to Dalton's theory. He too substituted for Dalton's geometrical symbols the initial letters of the names of the elements, which we use to-day. Berzelius had an encyclopædic mind, and he embodied in ten volumes the whole compass of chemical knowledge enriched by many of his own discoveries. Conservative as to the ideas which had served him well, he had the intuition to see where there was a common pattern in diverse chemical phenomena, and we owe to him the generalisations of isomerism and catalysis and their names.

For twenty years Berzelius was the accepted authority and the influence he exerted through his Annual Reports on current literature and through his friendships with the younger generation of chemists was immense. Meanwhile the younger men like Liebig, Wöhler and Dumas were laying the foundations of organic chemistry by making series of derivatives from natural products with inorganic reagents. The new facts they discovered were difficult to reconcile both with the dualism and the theory of radicals which Berzelius had inherited from Lavoisier, and with his own view of the dependence of chemical affinity on electrically charged atoms. By 1841 his authority was seriously challenged. His formulæ were discredited, even his atomic weights were largely replaced by equivalents, and there was a drift from theory towards empiricism.

Founding of the Chemical Society

So the Chemical Society was founded at a most opportune moment, when the number of young men doing research was rapidly increasing and the opportunity for discussion and publishing their results was badly needed. For the next twenty years chemistry was to be in a state of flux, without any generally accepted theory. It was a time of bitter controversy, when the older chemists resented criticism and the younger men like Gerhardt and Laurent suffered persecution for their views. In their heroic battle against authority, which they ultimately won, Pope's lines, often spoken in jest of our profession, came literally true:

> "The starving chemist in his golden views
> Supremely blest, the poet in his Muse".

Laurent died as a result of privation.

From 1840 to 1860 the work of most outstanding chemists lay in organic chemistry. It was a period of rapid growth, when experiments were almost bound to lead to discoveries. Each chemist had his own theory of which he was tenacious, as it meant much to him; it was in a sense the scaffolding which enabled him to make his own contribution to the structure of chemistry. And so it is not surprising that by 1859 a whole page of Kekulé's text book was filled by the different formulæ proposed for such a simple substance as acetic acid.

As the technique of organic reactions was gradually developed, each year brought an increasing harvest of new compounds and there was a growing need for some new system of classification to include them all. Laurent and Gerhardt, with their logical French minds, had each been seeking a new basis of classification along rather different lines, and their partnership led eventually to Gerhardt's type theory in which all organic compounds were derived by substitution from four simple inorganic substances, hydrogen, water, hydrochloric acid and ammonia. Gerhardt's theory was an unconscious recognition of the different combining powers of the atoms and groups, and led inevitably to Kekulé's theory of atom linkage. It had been a long struggle, and Laurent died in 1853, but Gerhardt lived until 1856 to taste success and see his views adopted by the younger chemists.

The early meetings of the Chemical Society during that stormy period must have been lively and stimulating, with men like Lyon Playfair, Graham, Brodie, William Odling (Gerhardt's *l'ami Odling)* and Williamson, to whose classic paper on ether and alcohol Gerhardt owed so much. And there were in London during those years young German chemists of great ability—Kolbe came in 1845, to infect the young Frankland with his interest in the synthesis of organic compounds from simple molecules. Hofmann came in the same year to teach at the new College of Chemistry in Oxford Street, and Kekulé in 1853 as assistant to Stenhouse, then Chemist to the Mint. Kekulé often said that his theory of the structure of organic compounds started in his dream about atoms on the top of an omnibus one night between Islington and Clapham Road where he lodged. So in those days London and the meetings of the Chemical Society which took place in this building from 1841 to 1849 were a focus of chemical thought.

Cannizarro and Kekulé

These two decades of uncertainty and divided opinion ended almost abruptly after 1860, thanks to the constructive thinking of two men. In 1860 the first international conference of chemists was held at Karlsruhe at Kekulé's suggestion, with the object of arriving at some agreement about atomic weights and molecular formulæ. Nearly all the active workers in each country were present, but like other international meetings progress was slow. Committees were appointed which grew larger and larger, there was jockeying for position and eventually the Congress broke up in a chilly mood, having accomplished practically nothing. But copies of a thin paper-covered pamphlet on atomic and molecular weights by Cannizarro, the Professor of Chemistry at Palermo, were given to some of the delegates. His exposition of the existing difficulties and their solution by the consistent use of the laws of Avogadro and Dulong and Petit was so clear and convincing that as Lothar Meyer said when he read it "the scales fell from my eyes, doubts disappeared and were replaced by a feeling of certainty". It was not long before there was a general agreement among chemists about the weights of the atoms and the number of atoms in a molecule, which, as Kekulé had foreseen, was a necessary preliminary to a general theory of the constitution of molecules.

The other decisive factor was Kekulé's theory of atomic linkages, each atom having a definite combining power—hydrogen one, oxygen two, nitrogen three and carbon four. On this basis, recognising that atoms of carbon, unlike other elements, could

unite to form stable chains, or rings like the six-membered benzene molecule, Kekulé was able to assign definite structures to organic compounds, and this gave an immense impulse to the advance of organic chemistry.

When these major controversies were over, chemistry advanced rapidly on a wide front in the years from 1860 to 1900 which form the next epoch.

Organic Chemistry, 1860–1900

Kekulé's theory of atomic linkage had presented chemists with an almost unlimited number of possible arrangements of carbon atoms in straight or branched chains, or in rings with intermediate links of other atoms which could also form part of closed-ring structures. These possibilities chemists were quick to explore, both by building up new molecules by synthesis in the laboratory, and by trying first to ascertain the molecular structure of natural products and then to synthesise them in the laboratory. Outstanding examples of this were the syntheses of alizarin in 1869 and of indigo in 1880. In this way many new compounds were made and described, and the technique of organic reactions was continuously extended. Between 1856 and 1910 the number of known organic compounds increased from 3,000 to 200,000.

In this period of rapid development there was one episode of outstanding importance, the simultaneous recognition by van't Hoff and Lebel of the need to take into account the arrangement of the atoms in three dimensions. Kekulé had realised this, but he was sceptical about the power of chemistry to reveal the actual structure of the molecule although he thought physics might do so. Pasteur in 1845 had already proved from the rotation of light passing through them that in certain cases the same atoms could form either a right- or a left-handed molecule. Van't Hoff and Lebel showed that this was due to the presence of one or more carbon atoms combined with four different groups which could be arranged spatially in right- and left-handed forms. In addition, the arrangement of the atoms in space could account for a number of other unexplained phenomena. All their predictions were quickly verified, and since 1874 stereochemistry, the arrangement of the atoms in space, has been a potent factor in the progress of organic chemistry.

During these years it was in Baeyer's laboratory that most of the foremost organic chemists served their apprenticeship. It was there that Emil Fischer, the younger Perkin, Willstaetter and many others learnt the simple technique of the test tube and glass rod with which so many discoveries were made before the elaborate technique of modern organic chemistry became necessary. The sugars, the terpenes and the alkaloids yielded the secrets of their structures. Some of the many new compounds that were synthesised were only of scientific interest while others yielded new dyes or new perfumes or new drugs like eucaine and veronal, so called because Emil Fischer happened to wake up and look out of his carriage window at Verona after a visit to Baeyer to discuss its properties.

Inorganic Chemistry, 1860–1900

The advance of inorganic chemistry naturally took a different course. In 1860 sixty-four elements were known and many attempts had been made to classify them in families with very limited success. When agreement had been reached as to

the relative weight of the atoms a new line of attack was opened and in 1864 both Newlands and Lothar Meyer pointed out that if the elements are arranged in the order of their atomic weights, elements recur at regular intervals with similar properties, apparently belonging to the same family. Four years later Mendeléeff, using more accurate atomic weights, developed the Periodic System in much greater detail and predicted by means of it the properties of three undiscovered elements which were missing from the system. The accuracy of his predictions was shown by the discovery of gallium in 1875, scandium in 1879 and germanium in 1886. The invention of the spectroscope by Bunsen and Kirchhoff in 1859 had given chemists a powerful new instrument, and the discovery of further new elements, rubidium, caesium and thallium soon followed with its aid, to fill other gaps in the Periodic Table of the elements. But even though it provided a basis for the classification of the elements in families, many puzzling problems in the Table remained unsolved.

Physical Chemistry, 1860–1900

Meanwhile the influence of physics on chemistry was being felt more and more, both in the use of new techniques like the spectroscope and in various applications of physical theory. Here again van't Hoff was the pioneer in a dual attack by applying both molecular theory and the laws of energy to the analysis of chemical phenomena. The laws of energy or thermodynamics are laws of experience like Newton's law of motion, independent of any hypotheses as to the nature of matter, and affording therefore a useful test of the truth of such hypotheses and of classifying and forecasting certain chemical phenomena. Willard Gibbs had been the forerunner in this field in 1876–78, but van't Hoff was the first to show the wide applications of thermodynamics to chemistry. At the same time he was analysing the kinetics of chemical reactions and the nature of chemical equilibrium in the light of molecular theory, and showed their dependence on the behaviour and properties of the individual molecule. Thus in the 'eighties a new subject, Physical Chemistry, was taking shape, especially in the field of solutions, where Arrhenius gave it a fresh impulse with his theory of electrolytic dissociation which related the electrical conductivity of solutions to the dissociation of molecules into electrically charged ions. That again had applications in many fields, and with the help of Ostwald and Nernst physical chemistry quickly became a powerful new instrument.

And so in the 'nineties, when I and my contemporaries were learning chemistry, organic chemistry gave us a tidy logical picture in which the agreement between properties and structure showed clearly that the model represented a close approximation to the truth. In physical chemistry we got a picture of the dependence of chemical reactions and equilibria on the kinetics of the individual molecule or ion, and of the value of thermodynamics in giving generalised laws independent of any theory. Inorganic chemistry was more difficult; by then there were so many isolated facts to be remembered, and while the Periodic Table was a great help, there were many anomalies still to be explained.

Nineteenth-century chemistry had been based on the Newtonian atoms, those small, hard, indivisible, elementary particles of which all matter was thought to be composed, and its development was mainly that of an experimental science. The

whole picture of molecular constitution had been built up by inference from macroscopic experiments, and there were no means of investigating the fine structure of matter to give some clue as to the nature of the atoms, of their chemical affinity that caused their reactions, or of their valency that determined their combining powers. The evidence of their spectra certainly suggested that their structures were far from simple.

Then suddenly there came a rapid succession of discoveries that threw an entirely fresh light on the whole subject and by 1914 had given chemists a new conception of the unity and sub-mechanics of their science.

THE PERIOD OF GREAT DISCOVERIES, 1895–1913

In 1897 J. J.Thomson discovered the negative electron, showing that electricity is atomic and that the electron is common to all atoms. Becquerel had already discovered radioactivity in 1896, and Madame Curie isolated radium in 1898. These discoveries, together with Rutherford and Soddy's systematic investigation of radioactive charges, gave the first clue to the nature of the atom.

Roentgen's discovery of X-rays in 1895, with wavelengths approximating to atomic dimensions, in the hands of von Laue and the Braggs proved a most powerful means of investigating the arrangement of atoms and ions in crystals and later the arrangement of the atoms in the molecule.

In 1911 Rutherford's discovery of the dimensions and nature of the nucleus led to his theory of the nuclear atom consisting of a small central positively charged nucleus with electrons rotating in orbits around it. Moseley in 1913, by examining the frequencies of the X-rays emitted by different atoms, proved that there are ninety-two elements with ordinal numbers corresponding to the number of charges on the nucleus, thus throwing an entirely new light on the Periodic Table. As a proof of the thorough way in which nineteenth century chemists had done their work, it is worth noting that of that complex and hitherto mysterious group of elements, the rare earths, fourteen had been separated and recognised as elements before Moseley's law was known, leaving only one of extreme rarity to be found.

The full significance of Rayleigh and Ramsay's discovery in 1895 of argon, the first of the rare gases, followed by Ramsay's discovery of the rest of the family, was now apparent. The arrangement of the electrons in their atoms was so stable that they showed no tendency to combination, and this was the basis of G. N. Lewis's and Kossell's theories of valency as dependent on the stability of an octet of electrons in the outer shell of the atom.

In 1901 Planck had shown that radiant energy had a certain atomic character, as it could only be emitted and absorbed in discrete quanta, the size of which was proportional to the frequency of the vibrations. The fundamental significance of this discovery to chemistry was not at first obvious, until Bohr in 1912 showed that the application of the quantum theory to the electron orbits in Rutherford's atoms could explain the structure of their spectra, the actual wavelengths of which could be calculated in simple cases.

Then, just as all the tools for future development were in the chemist's hands, came the war of 1914, the first chemists' war, in which chemistry played a vital part in making explosives, in making synthetic products to counter the effects of a

blockade and in the military use of gas and smoke. The effect of this was to intensify the effort directed to chemical research after 1918.

Chemistry in the Inter-War Years

Demobilised from their war activities, chemists returned to their laboratories with fresh zest to take up again the work that had held so many exciting prospects in 1914. I remember Rutherford saying to me in 1919: "What's the use of going back to chemistry when Bohr will soon to able to calculate anything you can find out?" But Rutherford was the last person to dissuade anyone from experimenting, and it was in his own laboratory that the science of nuclear physics was born.

During the inter-war years chemistry has progressed with amazing speed, and its influence has been felt increasingly in the sister sciences of physiology, botany, agriculture and geology. The main factors in its progress have come from physics, both from new physical techniques and from new physical theories. Progress has been on such a wide front that it is impossible to summarise, but there seem to me four outstanding achievements in the fields of atomic and molecular structure, of nuclear physics and isotopes, of the kinetics of chemical action, and of the organic chemistry of living processes.

Atomic and Molecular Structure

Chemistry owes to Physics the detailed knowledge that we now possess of the structure of molecules, derived from measurements of their X-ray diffraction, electron diffraction, Raman spectra, dipole moments and their spectra from the infra-red to the ultra-violet. There has been a continuous development both of the technique and of its application in each field since 1919. Thanks to this we now know the distances between the centres of the atoms in any linkage, the position of the atoms relative to one another, the nature of the linkage, the heat of formation of the linkage and its resistance to deformation.

Simultaneously with this advance on the experimental side there has been a remarkable development on the theoretical side which has stimulated experiment and has explained the causes underlying the behaviour of the atoms and molecules.

Till 1925 the Bohr-Rutherford atom held the field, the positively charged nucleus with electrons rotating round it in various orbits. From the purely chemical side it gave a qualitative explanation of the valencies of the elements, it distinguished between electrovalent, covalent, and co-ordinate links, and it explained most of the regularities of the Periodic System. It gave a quantitative basis for calculating the spectra of atoms and simple molecules, and with the hypotheses of electron spin and molecular vibration it accounted for the fine structure of spectra and their behaviour in a magnetic field.

But difficulties arose with the model atom as the electron sometimes appeared to behave as a particle and at others as a wave motion, a dilemma that was the basis of Heisenberg's Uncertainty Principle. The difficulty was solved by the new calculus of quantum mechanics, in which the properties of the atom are described by equations which admit of no simple physical interpretation such as a model. The test of their validity is the wonderful accuracy with which they can predict the behaviour of single atoms. Unfortunately in more complex systems great mathe-

matical difficulties are involved in a rigid solution, and various methods of approximation have to be adopted. However, in spite of this, quantum mechanics has provided a new stimulus and a new interpretation in many fields, particularly in regard to valency. It enables the direction of the valencies of any atom in space to be calculated, and provides a much more subtle differentiation of the various types of linkage. The periodicity of the properties of the elements with increasing atomic number can be shown to be a necessary consequence of the geometrical symmetry of the electron fields. It explains too the quantum restrictions as a necessary consequence of the wave characteristics of the electron.

Isotopes

The nucleus itself is mainly the concern of pure physics, but there is one important exception, the existence of isotopes, atoms with the same atomic number but with nuclei of different mass. By means of his mass spectroscope Aston showed that the chemical elements are nearly all mixtures of isotopes, and by measuring the amount of each present and its atomic weight he explained why chemical atomic weights are so far removed from whole numbers. The actual separation of the isotopes with identical chemical properties by physical means was one of the most laborious experimental problems with which chemists have been faced.

But a new significance was given to isotopes when the physicists found it possible by bombarding atomic nuclei with various particles to transmute them and often to produce isotopes with radioactive properties differing from those of the parent atom. Quite apart from their therapeutic importance, such isotopes could be used as tracer elements in chemical reactions and in living processes to track down the course followed by the atom in question.

Physicists also discovered the particles of which the nucleus is composed, the positron, the positive equivalent of the electron, and the neutron, whose unique properties as a projectile in nuclear bombardments makes possible the utilisation of atomic energy.

The Kinetics of Chemical Change

This brings me to the next main field of progress, the kinetics of chemical reactions. It is generally true to say that no phenomenon is as simple as it seemed to the original discoverer, and of nothing is this so true as of the equations used to represent chemical reactions. Only last year our President's Bakerian Lecture was devoted wholly to the complexities of that first schoolboy equation: $2H_2+O_2=2H_2O$.

The investigation of reaction rates has given scope for much ingenious experimental and mathematical treatment. It has involved the study of the lives of the individual molecules, the circumstances under which they can acquire a critical amount of energy, the effect of radiation, the effect of catalysts, and the significance of chain reactions. Great progress has been made, which has given us a much more intimate picture of the actual mechanism by which chemical reactions take place. The results are of profound interest both for theory and practice, as so often it is the rate of change that determines what is possible.

Organic Chemistry

And lastly there is organic chemistry, when we must go back to where we left

it about 1900. Its outstanding achievement has been the light it has thrown on the great systems of the materials and processes of living organisms. Organic chemistry has thus returned to the task for which it was originally equipped by Lavoisier and for which he meant to use it, the discovery of the chemical reactions of the living body. Its success has been to reveal their complexity. With the techniques that have been developed by organic chemists for over a century they can now break down or build up the most complex structure of carbon atoms and the groups attached to them with a certainty that leaves no doubt as to what that structure is.

Here again physical methods have played an important part. X-ray analysis of crystalline or regularly orientated material has revealed the details of its atomic and molecular structure. Infra-red spectra have made possible the identification of minute quantities of material differing only in small details of their structure. The modern methods of chromatography, the selective adsorption of substances in various media, allow of the separation of the constituents of complex mixtures available only in small quantities which otherwise could not be resolved. The ultra-centrifuge too has helped in the separation of complex molecules and the determination of their molecular weights. The technique of microchemistry, the handling and analysis of small quantities of organic material, has made possible the investigation of substances available only in small quantities and quickened the pace at which investigations can proceed.

The problem for the chemist, in conjunction with the physicist and the biologist, is to unravel the processes by which nature builds up the structure of living organisms, and provides the materials that discharge the functions of their various parts.

The plant is the first stage in nature's economy, as plants alone can assimilate the carbon dioxide of the air and nitrogen from inorganic sources and synthesise from them the carbohydrates, fats and proteins that form the food of other organisms. The first success of chemists in this field was the determination of the structures of the simple plant products, such as the sugars, vegetable oils and fats, essential oils like the terpenes, rubber, alkaloids, and various dyestuffs and colouring matters like the anthocyanins. Many of these were synthesised in the laboratory, and X-ray analysis has confirmed the correctness of the structures assigned to them on the ground of chemical behaviour. A comparison of these structures shows that nature makes use of the economy of prefabricated construction, as many of them are built up by different arrangements of the same groups of carbon atoms. Thus the carbohydrates are all built up of chains of six carbon atoms, but C_3 may be an intermediate stage in this grouping, as the groups C_6-C_3 and $C_6-C_3-C_6$ frequently occur in plant products. The vegetable fats and oils are mostly built up of C_6 units forming chains containing twelve, eighteen or thirty atoms, joined together by the C_3 of glycerine. The structural units C_6 and C_3 recur again in a number of substances where the chain of six carbon atoms has been converted into a ring as in the oil of cloves and similar substances. Two C_6-C_3 groups provide the skeleton of many others, and with the addition of C_6 the skeletons of the catechins and anthocyanins. The aromatic oils, resins and rubber have been found by a different route; they are built up from a C_5 unit with a branched carbon chain which may either condense to rings like the terpenes or polymerise to a long chain as in rubber.

But in spite of these regularities we have little knowledge of the methods by which nature marshals these units in the living cell. Her catalytic methods are so specific in their actions and work so cleanly compared with ours that she is able to marshal these structural units to form complex molecules under the influence of surface forces exerted as it were by a template of existing molecules. The ease and certainty of nature's methods is so intriguing and tantalising to the chemist working in a non-living environment.

It was quickly realised that many of the main constituents of living organisms, the polysaccharides and the proteins, had vastly greater molecules than these simple plant products, and here again X-rays have rendered decisive help. Cellulose, for instance, was found to consist of hundreds or thousands of glucose residues united in a straight chain, and forming the chain bundles which are the predominant structural element of the plant kingdom. In rubber the long carbon chains are folded higgedly-piggedly around one another, straightening when the rubber is stretched and giving it its elasticity. The discovery of formaldehyde phenol plastics by Baekeland in 1909 soon resulted in the synthesis of similar giant molecules in the laboratory and the study of their behaviour. Carother's classical investigation of the linkages which would produce these giant molecules led directly to the discovery of nylon, a nitrogenous synthetic fibre that is competitive with nature's products.

Of all these giant molecules the proteins, which in one form or another enter into almost every living process, are the most significant. Emil Fischer's pioneer investigations showed that they all consist of various amino-acids linked together to form long chains. X-ray analysis revealed the regular order in which the amino-acids alternate in the chains of different proteins and the position in space of the side groups, the projections from the chains that determine so largely the specific properties of each. The proteins are divided into two great families, the fibrous and the globular, those in which the chains are extended like fibroin, the spider's web, and those in which they are coiled in a regular manner like albumin and hæmoglobin. The former class has again two main families, the keratin-myosin-fibrinogen group, including wool, hair, skin, nails, whalebone, muscle tissues and the coagulating constituent of blood, and the collagen group including tendons, connective tissue and cartilage. The knowledge of their chemical structure reveals something of the principles of nature's engineering, of the way in which she provides for the necessary mechanical properties of the parts of an organism. And further it is beginning to throw light on the processes of growth, the synthesis of giant molecules by contact catalysis in living matter.

Great advances have been made in our knowledge of enzymes, those complex colloidal catalysts formed by living cells which enable the chemical changes that accompany and condition living processes to take place rapidly at ordinary temperatures. The isolation of some of them like urease, trypsin and pepsin in a crystalline form was a great achievement. Some have proved to be pure proteins, while others, such as those responsible for the oxidation of food in the body, are proteins associated with various complex groups which can act as oxygen acceptors.

Then there are substances such as the vitamins, hormones and auxins, small quantities of which exert such an immense effect on living functions. Vitamins are

essential to normal life and healthy growth, and are all derived from foodstuffs. Their identification has played an important part in the modern treatment of nutrition, and the constitution of most of them is now known. Hormones are the chemical messengers, produced in one part of the body and exerting a most potent influence on others. Some of them, such as the sterols, and the active principles of others, such as adrenalin and thyroxin, have been isolated; their structures have been determined, and some of them have been synthesised. The knowledge gained in this way has been of the greatest value in curative medicine.

Lastly, there are the viruses, those minute carriers of disease that have been so hard to track down and isolate. Some of them have now been obtained in a crystalline form and have been shown to be nucleoproteins.

In addition to throwing light, in these and many other ways, on the complex molecules and the complex secrets of the chemical reactions on which the existence of life is dependent, chemists have synthesised many new substances which have important biological applications. Ehrlich's discovery of salvarsan in 1910 was an outstanding triumph. Its name "606" emphasises the number of attempts before a molecule was found that would destroy the spirochete of syphilis without killing the patient. Later came the sulphonamides with their specific reactions against certain types of bacteria. Their power of stopping growth suggests that they are absorbed on the catalytic surfaces in place of some of nature's prefabricated units of similar shape, and thus prevent the completion of the pattern and the formation of a new molecule. Their action has been likened to the jamming of a lock by a key that does not quite fit.

D.D.T. and gammexane come in another category. They are synthetic products of outstanding effectiveness in killing insect pests without hurting men or animals. Similarly a range of substances has been found which will kill weeds, dicotyledons, without damaging the growing crops which are monocotyledons.

One of the greatest triumphs of chemistry in the chemotherapeutic field has been the isolation of penicillin, and the elucidation of its structure, the last details of which were revealed by X-ray analysis, and finally its synthesis.

All these examples, and they are but a few of many, go to show what an effective instrument chemistry has become, working with her sister sciences in revealing both the possible combinations and permutations of the elements of which the world is made, and the nature of the processes associated with living organisms. But in addition, chemists have a great record of achievement in the application of all this accumulated knowledge to the service of mankind. And this brings me to the progress of chemical industry during the last hundred years.

Chemical Industry

Our industry is, I know, of special interest to the Royal Society of Arts with your wonderful record of almost 200 years of activity devoted to the encouragement of the practical applications of scientific discovery. The progressive stages of civilisation have in fact been largely conditioned by the materials available to mankind. From the Bronze Age to the present age of light alloys and plastics there has been a steady advance in the exploitation of natural materials to serve the needs of man, and in this the chemist has played the decisive role.

Chemical industry in 1841 was still in an embryo stage; it had not yet felt the effects of the great industrial expansion of the nineteenth century, nor of the impact of science on industry. It was mainly concerned with the manufacture of acids, alkalis and mineral salts, with the extraction of natural products like sugar and dyestuffs, and with various fermentation processes.

The first major development came from the progress of organic chemistry. Perkin's discovery of mauve in 1856, the first synthetic dyestuff, started a new industry. One result was the first displacement of a natural product, when alizarin was synthesised in 1868, and the synthetic material quickly supplanted the cultivation of madder. Baeyer's synthesis of indigo in 1880 again led to the gradual displacement of the indigo crop.

With the rapid advance in the discovery of improved and faster colouring matters and the discovery of synthetic drugs like phenacetin and sulfonal, the organic industry grew rapidly. Although it had started in this country with Perkin, and Germans like Caro and Otto Witt came here to serve their apprenticeship, it was not long before Germany had secured the lead, mainly owing to her lavish investment in research. The scientific basis on which the organic industry had developed undoubtedly had a considerable influence on the development of the chemical industry as a whole.

In the heavy chemical industry the decisive episode in this country was I think the courageous and far-sighted decision of Ludwig Mond and John Brunner in 1872 to use the Solvay process for making soda. Their means were slender and several firms had already had to abandon the process. But Mond saw its possibilities, and for the first two years at Winnington he watched the process by day and night. The scientific control of the plant by which he achieved success and his skill in plant design marked the birth of chemical engineering in this country.

Other major factors were now at work to expand the scope of the industry. First came the demand for artificial fertilisers to meet the food demands of the rapidly growing industrial population. Then the availability of electrical energy from the dynamo gave a new impetus to the use of electrolytic methods to produce metals like aluminium, magnesium and sodium, and alkali and chlorine, and of the electric furnace to make calcium carbide and other products.

The demand for explosives and the invention of gun cotton, dynamite and high explosives built up another section of the industry. The peaceful uses of cellulose products, nitrocellulose, cellulose acetate and viscose provided another field of development, and in each new field the links between science and industry were drawn closer.

The successes of chemical engineering were achieved by plant design and process control. The design of plant was based on accurate quantitative knowledge of the reactions concerned, on securing maximum heat economy, on the use of an ever-increasing range of anti-corrosive materials, and on the use of the most efficient catalysts. Continuous control of processes was obtained by recording instruments at each stage and by analysis. The study of catalysis led to revolutionary changes first in the manufacture of sulphuric and nitric acids and ammonia and later in the whole range of the industry. The catalytic hydrogenation of vegetable oils was an outstanding contribution towards the supply of the world's demand for fats.

Then came the war of 1914, in which the chemical industry became almost a decisive factor by the production of explosives and fertilisers. In fact, without the Haber process for making ammonia, the blockade would quickly have compelled Germany's surrender. The war thus demonstrated the strategic importance of the chemical industry. To quote a sentence from the report of the mission which inspected the German chemical factories in 1919: "In the future it is clear that every chemical factory must be regarded as a potential arsenal, and other nations cannot, therefore, submit to the domination of certain sections of chemical industry which Germany exercised before the war. For military security it is essential that each country should have its chemical industry firmly established". The lesson we learnt then was not forgotten.

As in pure chemistry, the inter-war period was a time of rapid development. The earlier development of synthetic chemistry had largely been in competition with nature. Steinmetz, the genius of Schenectady, once said to the head of the I.G., "Bosch, I know you can make indigo cheaper than God, you may some day make rubber cheaper than God, but you will never make cellulose cheaper than God".

With the discovery of plastics and the vast possibilities of the synthesis of large molecules there has been some competition with natural products, such as nylon with silk, and synthetic rubber with the plantation product, but much progress has also been made in processing and upgrading vegetable products, such as cellulose, starch, vegetable oils and in the use of farm by-products. The processing of foodstuffs, including crop drying, is another field in which chemical industry and agriculture are establishing a new community of interest. These developments are of great significance, as it means that industry is drawing increasingly on the revenue account instead of the capital account of the world's resources for its raw materials.

I must not omit, however, some reference to the remarkable technical progress of the petroleum industry in the inter-war years. The refining of crude oil was revolutionized by the use of catalysts, and most recently by the use of the so-called fluid catalyst, small particles suspended in a current of the reacting gases. In addition to making petrol of high octane value and other fuels, a new industry has been built up on the hydrocarbon gases from the cracking process and the natural gas from the oilfields. From them an immense variety of chemicals are now made, such as iso-octane, synthetic rubber, and solvents of all kinds. Under the pressure of autarchy oil was made from coal, by hydrogenation and by the Fischer-Tropsch process, which is now expected to produce petrol and hydrocarbon gases at a price competitive with crude oil, starting from natural gas and using a fluid catalyst.

Once again we have seen how war has tested the resources of the chemical industry, when it proved its ability to produce, at a cost, whatever was needed from the available raw materials, whether it was aviation fuel, rocket fuel, synthetic rubber or synthetic fibres. Chemical engineers too played a great part in the vast organisation, with all its attendant difficulties, necessary to separate the quantities of uranium 235 and plutonium in the state of purity needed for the atomic bomb. And their work opens up a vista of possibilities of the use of atomic energy for peaceful purposes.

CONCLUSION

Thus in its industry, as in pure science, chemistry has a great record of achievement. Looking back at the state of knowledge when our Society was founded here in 1841, we see a wonderful century of progress. And in this the Fellows of the Society have always played a leading part. But it is well to remember that that swift advance has depended on the efforts of men in many countries working together with a common aim, with no tariffs or visas to hinder the flow of new ideas.

And I cannot help reflecting on the contrast between this record of achievement and the sorry state of the world to-day. Is it not paradoxical that with the understanding we have won of nature's secrets, with our power to control nature in action, that the majority of mankind should still be suffering from malnutrition and many from endemic disease? This seems to me a challenge to science and not least to chemists. Is sufficient effort being devoted to the application of the knowledge we already possess? What should be the priorities? How can we ensure that the same concerted effort is made to use that knowledge for the peace and contentment of the world as made it such a potent factor in the war? That is the thought I would leave with you at the beginning of our second century.

THE CHAIRMAN: I will now ask Professor R. P. Linstead to read a message from the President of the Chemical Society (Professor C. N. Hinshelwood), and in his stead to propose a vote of thanks to the lecturer.

Professor R. P. LINSTEAD: The message to which the Chairman has referred reads as follows:

> "The President of the Chemical Society sends best wishes for joint meeting, and greetings to his old friend and teacher, Sir Harold Hartley, and regrets illness prevents attendance".

I am sure we are all extremely sorry that the President of the Chemical Society was unable to be with us this afternoon. I know he himself must regret this very deeply, not only because of the nature of the occasion, but because of his own personal contacts with Sir Harold Hartley.

I think we would all agree that we have listened to a most worthy lecture on a fascinating theme.

This is a very important occasion, not only in the life of the Royal Society of Arts and the Chemical Society, but of what I might call organised chemistry throughout the world, because the Chemical Society is the pioneering organisation of chemistry, and we have now led the way to our centenary.

There is very little which can be said in a few words about Sir Harold Hartley's talk. He covered an enormous range, and one does not know whether to admire most the selection of material or the most brilliant treatment which he gave to it. One was conscious throughout of the extraordinary skill with which he held the balance between the two aims and objects of chemistry, and indeed of any physical science—aims which were expressed once for all by one of our philosophers upon whom we base so much of our thinking, when he said that our objects are two: the extension of the knowledge of causes, and the extension of the bounds of human empire. Those words of Francis Bacon underlie the message which Sir Harold has given us this afternoon One has only to look round at the state of the world to-day. To take one thing only—the enormous increase in population. Since the founding of the Chemical Society the population of this country has trebled. It has trebled because it had enough food, and it had enough food because it had enough fertilisers, and it had enough fertilisers because it had enough chemists and chemical engineers to deal with their provision.

There are innumerable other ways in which the impact of chemistry upon our thought and our daily life is felt.

This is an important occasion, not only because of the lecture we have heard, but because of the fact that it has been given under the joint auspices of the two Societies. That is indicated in certain documents which are exposed on the table before us, and which are open for inspection afterwards. These include the original Minute Book of the Chemical Society, with the record of that day just over a hundred years ago, in February, when the first meeting was held here. There is also the Jubilee Album, which contains a number of most interesting records of the Founder Members, including photographs, and the Obligation Book, which members have signed.

I think we can look upon this meeting as symbolising the great friendship between the two Societies. We of the Chemical Society are extremely grateful to the Royal Society of Arts that this friendship, which started in our infancy, has continued into our maturity. In fact, I think we can look upon the Royal Society of Arts in the words in which Quiller-Couch in one of his dedications referred to a certain university, as our "most kindly nurse".

It is on record that Robert Warington, our first Secretary, when he asked permission to hold our first meeting under this roof, said "This request was acceded to in the handsomest manner". I think we of the Chemical Society can now say that the Royal Society of Arts is continuing to behave to the Chemical Society in the handsomest manner.

In conclusion, if I may speak for both Societies, I would say that this historic occasion has been marked by the presentation of an historic lecture, and we are very greatly indebted to Sir Harold Hartley for that lecture. I have much pleasure in proposing a vote of thanks.

THE CHAIRMAN: Both Societies obviously are unanimous on this, Sir Harold. We thank you very much.

The vote of thanks was carried with acclamation and the meeting then terminated.

CORRESPONDENCE

CRAFTSMANSHIP

In the paper on craftsmanship in the *Journal* of May 9th, we are told that "with industrial craftsmanship the hand in general is eliminated", and that "the operative is rapidly degenerating into an unthinking industrial automaton". Quite so; and that is why we want more individual craftsmanship in industry, as well as competent designers for the machine. It is not only in the case of woodcarving, to which Mr. Reco Capey refers, that the demand for manual skill exceeds the supply. There is also a shortage of carpenters, blacksmiths, and bricklayers. No intelligent person now doubts that machine work can play an important part in educating public taste, nor that a selection of it would suitably enliven the rooms of some of our antiquated museums; but it is equally clear that there will always be a demand for the higher forms of art in which handwork is indispensable, and to whose service the pioneers of the artistic revival in the last century in their search for fundamentals, were properly devoted.

It is indeed as idle to regret that the author of the *Earthly Paradise* refrained from the uncongenial task of perfecting mechanical design, as it would be futile to complain that William Blake failed to co-operate with Blackett in the building of "Puffing Billy". Each to his choice. For such a superb craftsman to turn from work which he alone could do to tackle a job which others—and notably his own disciple, William Benson—would presently do as well or better, would have been a sheer waste of time and talent. In fact, Morris was one of the few Victorians who really understood both the immense potentialities of the machine as a servant-of-all-work and its limitations in art. The advice to designers for machine work in his Lectures on Art and Industry (which has perhaps escaped Mr. Reco Capey's attention) shows, as might be expected, a complete grasp of the subject and has not since been bettered.

P. A. RICE.

OBITUARY

Sir HUMPHREY LEGGETT.—In the previous issue of the *Journal* we announced with regret the death of Major Sir Humphrey Leggett, D.S.O., formerly a Vice-President of the Society and Chairman of the Dominions and Colonies Committee.

Edward Humphrey Manisty Leggett was born in 1871, and was educated at Clifton College, and at the Royal Military Academy, Woolwich. After gaining a commission in the Royal Engineers, he worked on the staff of the London and North Western Railway and went to the International Rail Congress in 1895 as British delegate. He served on the headquarters staff throughout the South African War, winning the D.S.O. and the brevet of major, and being mentioned in despatches. From 1902 to 1905 he was director of the Burgher Camps and Settlements in the Transvaal, and from 1907 to 1910 was lent to the Colonial Office for special duty in East Africa and Uganda. During this latter period he served on the Legislative Council of British East Africa. From 1914 to 1918 he was attached to the Belgian War Office, and was knighted in 1920.

After his retirement from the Army Sir Humphrey became managing director, and later, chairman, of the British East Africa Corporation, and had other interests in East and South Africa. From 1919 till 1930 he was Chairman of the East African Section of the London Chamber of Commerce, and from 1925 onwards was on the Council of the British Empire Producers' Organisation, of which he was Deputy Chairman for a time. Sir Humphrey had been a Fellow of the Royal Society of Arts since 1896, and first served on the Council in 1917. After a break from 1920 to 1922, he sat on the Council up to 1940, and had two terms of office as a Vice-President. From 1925 to 1941 he was Chairman of the Dominions and Colonies Section Committee.

Sir FREDERICK GOWLAND HOPKINS.—The previous issue of the *Journal* also announced the death of Sir Frederick Gowland Hopkins. the eminent bio-chemist, who in 1934 was awarded the Society's gold Albert Medal.

Frederick Gowland Hopkins was born in 1861, and at the age of seventeen was enabled by a legacy to start his scientific studies. He studied chemistry at the Royal School of Mines and at University College, and later joined the medical school at Guy's Hospital and was elected to a research studentship. Later he was invited by Sir Michael Foster, the founder and editor of the *Journal of Physiology*, to come to Cambridge to work on teaching and research in the chemical side of physiology. He accepted the invitation, and in 1901, shortly after coming to Cambridge, made the first of his great discoveries when, with S. W. Cole, he isolated and identified the amino-acid tryptophane. The work of biochemical discovery went on, and fundamental contributions were made to the knowledge of carbo-hydrate metabolism and nutrition. In 1906 the first announcement of the importance of what are now known as vitamins was made. A succession of appointments culminated in his becoming, in 1921, the first Sir William Dunn Professor of Biochemistry. In 1925 he was knighted.

Sir Frederick took an active part in the direction of State research, and was a member of the Advisory Committee on Nutrition set up by the Ministry of Health. In 1931 he was elected President of the Royal Society. His numerous honours included the Order of Merit, and the Nobel Prize for Medicine.

SIR THOMAS HOLLAND.—With reference to the death of Sir Thomas Holland, announced in the previous issue of the *Journal*, Mr. G. K. Menzies writes:

As Secretary of the Society during Sir Thomas Holland's Chairmanship of the Council (1925-7) I should like to add my tribute to Professor Gibson's appreciation of this outstanding scientist and administrator, and to say with what pleasure we welcomed him back to the Council last year after his retirement from the Vice-Chancellorship of Edinburgh University. With his characteristic ability, wisdom, energy and thoroughness, he quickly mastered all the details of the Society's finances. In so doing he introduced a new conception of the Chairman's duties, as hitherto such domestic matters had

been regarded almost entirely as the concern of the Secretary, Accountant and Auditors. In spite of all his other public activities his time, advice, help and judgment were always put ungrudgingly at my service, and in addition, I and the rest of the staff owe him gratitude for the establishment of the contributory pension scheme mentioned by Professor Gibson. Although the Society had not always been unmindful of the services of its superannuated officers, it has been put on record that one former Secretary ended his days in Marylebone Workhouse.

Of Sir Thomas's two Inaugural Addresses as Chairman, the first put on record his regret that India, after being driven to expand her industries during the 1914–18 War, was afterwards " doped with fiscal protection instead of being prepared to develop its own resources in a healthy way." He read two other papers before the Society, in one of which (the Trueman Wood Lecture of 1929) he developed his theory of " The Mineral Sanction" for the prevention of war. He told me at the time that he had submitted his proposal to many of those in high places, including Field-Marshal Smuts, and that none of them had been able to detect a flaw in the argument. Still more difficult problems now confront the scientists of the world.

GENERAL NOTE

EXHIBITION OF "ART IN MEDICINE".—Messrs. William and Gilbert Foyle are presenting an exhibition of clinical and pathological drawings and paintings of hospital life by Anna Zinkeisen, R.O.I., R.D.I., medical artist to St. Mary's Hospital, Paddington, at Trefoile House, Charing Cross Road, London, W.C.2. The exhibition was opened by the Right Hon. Lord Moran, P.R.C.P., M.C., on May 21st, and will remain open from 9 a.m. to 6 p.m. daily (including Saturdays) until June 19th.

In his Foreword to the catalogue, the Right Hon. Viscount Bennett, P.C., K.C., LL.D., draws particular attention to the excellence of the drawings made by Anna Zinkeisen for the Penicillin Train, which are among those included in the exhibition, and also to the striking studies of air-raid casualties made by the artist during the actual bombing.

NOTES ON BOOKS

WAR MEMORIALS. By Arnold Whittick. Country Life. 30*s*.

In 100 pages of text and 80 pages of illustrations, Mr. Arnold Whittick traverses the history of memorial art from the ninth century B.C. to the present day, and sets forth suggestions for memorials of the recent war of a local, national and international character. He discusses both the spiritual aspects of the problem and such practical matters as the choice of site and materials and the importance of the felicitous wording of inscriptions and of good lettering. We know of no work which provides such a wealth of material to guide war memorial committees towards a right solution of their local problems. Mr. Whittick's enunciation of the principles of memorial art seem to us entirely sound. When he passes from the general to the particular, however, he permits himself some startling assertions—as when he says of Lutyens's memorial of the Battle of the Somme at Thiepval: "No memorial arch of the ancient or modern world has such beauty of proportion or conveys in monumental form such an expression of inspired achievement".

Particular importance is lent to Mr. Whittick's chapter on a National Memorial by the apparent decision of the authorities that the addition to the Cenotaph of the dates 1939-1945 provides an adequate memorial of the great effort of the nation and the Empire in the Second World War. As to the site of a national or Imperial memorial Mr. Whittick well says, "The vicinity of the Houses of Parliament, Westminster Abbey and the Government offices in Whitehall is regarded as the centre of the nation and the heart of the Empire, and it is here that the nation would most probably desire its war

memorial". The authors of the County of London Plan have proposed a "precinct" for Westminster. It will be a tragedy indeed if too many utilitarian developments are permitted in this area. (One laments the intention to erect a block of office buildings for the use of Members of Parliament on a site in Abingdon Street, which otherwise developed would open up a wonderful new view of the Abbey.) A memorial garden, to which the whole Empire might make contributions in kind, was suggested in the debate a few months ago in the House of Lords.

Mr. Whittick's book reminds us that both nationally and locally we have a duty to place on record our deep indebtedness not only to the fallen, but indeed to all who served. Further we have, in the words of Lord Chatfield (who contributes a wise foreword to Mr. Whittick's book), to commemorate "a great ordeal and a great deliverance". If locally and nationally we can provide memorials of beauty and inspiration, we shall not merely "honour the brave", but may guide to deliverance succeeding generations through the ordeals with which they will be beset.

This thoughtful, comprehensive book makes a notable contribution to this end. Its illustrations—a matter in which Mr. Whittick has had the guidance of a committee nominated by the Royal Society of British Sculptors and the Royal Institute of British Architects—are as well chosen as they are well reproduced.

A. R. N. R.

DAUMIER. THIRD-CLASS RAILWAY CARRIAGE. With 19 illustrations, and an Introduction by S. L. Faison, Jr. Gallery Books, No. 13. Percy Lund Humphries & Co., Ltd. London. 4*s*. 6*d*.

To the observant, and perhaps more particularly to the artist, the fellow passengers in a public conveyance offer endless subjects of interesting study; more especially those on the short stages of local bus, tram or railway, where the material of the ebb and flow of the human stream is ever changing, presenting besides individual subjects, a general reflexion of the social status of the localities traversed, and the influence of the hour of the day on the immediate activities of the people.

Daumier was especially attracted by this cosmorama of the fluctuating tide of humanity; and sensitive to the latent story as adumbrated by the expression, bearing and appurtenances of each individual, recorded his impressions in vigorous brush or pencil pictures. By nature he seems to have been morbidly inclined, and although showing at times a somewhat grim humour, his sensitiveness to the hardships of the life of the indigent struggling masses, rejected the lighter touches so often present in these passing dramas of humanity and dwelt on the sadness untempered by the relieving glimpses of fun. He himself was destined to suffer in later life one of the hardest blows that Fate could deal an artist—failing eyesight and ultimate blindness.

In the picture selected for study in this monograph the passengers are just the miscellaneous types of men and women such as would be taken up at successive suburban stations; from the industrious peasant to the "black-coated" citizen. The chief interest is centred on the group occupying the seat immediately opposite us: two women, probably mother and daughter, the latter with an infant in her arms, and a small boy deep in sleep. Superficially, they are faithful studies, but the artist by sympathetic insight, has seen deeper. The elder woman, her heavy-lidded eyes weighted with accumulated experience of happiness and sorrow, is day-dreaming, gazing perhaps into the past when she held on her lap an infant, that daughter who now cherishes her own child; perhaps thinking of the activities of the moment or those just ahead. With hands clasped on the handle of her basket, resting, but still capable of dealing with any call for action, she seems to have attained a calm, philosophical estimate of life. Her daughter is wholly engaged with her sleeping infant whom she watches with downward regard, as cushioned in the crook of her plump arm, her sensitive fingers protectively outspread, she gathers the precious burden to her abundant breast. The sleeping boy, limp and utterly relaxed, hands in pockets, probably dreams of adventures more daring even than those in which his waking hours are restlessly engaged.

In the further compartment of the carriage the mixed company of men and women are more animated. The women seem to be hatless, but the men wear strange and various headgear, among which the several top-hats, in more or less advanced stages of dilapidation, exhibit a continental variant of this always grotesque erection.

The artist must have had peculiar regard for this study, first sketching it in water-colour and afterwards, with very slight modification, painting it in oils. The first is in the Walter Art Gallery, Baltimore, and the second in the Metropolitan Museum of Art, New York.

Supplementary to this study are others of the First and Second Class Carriages, reproduced here. In these, too, the types are searchingly portrayed and in some cases something more. The suggestion of bodily discomfort and mental worry expressed by pose and face of the sleeping man in the Second Class Carriage, for whom even fitful dozing fails to dispel his cares and perplexities: and the hopeless outlook of the man beside him, are evidence of the artist's sympathetic understanding.

Daumier has been called a great caricaturist—by his friend Daubigny "the Michael Angelo of caricature"—but if the word is taken to include a sense of humour in delineation, it is ill suited to the quality of sadness that pervades these studies, and the author is justified in stating that the artist was intensely concerned with the drabness of the lives of the "people", but he was equally keen to observe the harassing cares of those of, socially, higher strata. In the expressive draughtsmanship of his work the drawing of the hands is notably fine and sensitive.

The author discusses the general technique of the artist and the construction of the picture, and draws attention to changes in reproducing in oils the earlier water colour drawing of the Third Class Carriage. Infra-red photographs are given to emphasize the character of the strong black flowing lines afterwards softened by the over-painting.

This issue is a worthy addition to the valuable series of monographs.

F. H. A.

LAND CLASSIFICATION FOR LAND-USE PLANNING. By G. V. Jacks. Imperial Bureau of Soil Science, Technical Communication No. 43. 1946. 4*s*. net.

This work, coming at a time when "planning" of all kinds is so very much the vogue, fills a real need. So many systems of classification of land for different purposes have been proposed and the literature on the subject is so widely dispersed, that a critical review of this kind, collating and correlating the relevant material, will prove of great value to any one concerned in the development of land areas. Inevitably, the subject must draw upon a wide field; soil science, agriculture, forestry, ecology, economics, regional geography and sociology are all intimately concerned in any system of land classification and few indeed are those with sufficient knowledge in all these spheres properly to integrate their respective contributions. Dr. G. V. Jacks, as Director of the Imperial Bureau of Soil Science, is unsurpassed in his qualifications to appraise the published matter and place it in correct perspective.

In the sense used in this work the term land classification "relates to the grouping of lands according to their suitability for producing plants of economic importance". Dr. Jacks stresses the importance of two fundamental points in any system of land classification for planning purposes, first, that the classification must, in the nature of things, be related to the objective of the plan; this is the major cause of the diversity of criteria which have been used. Secondly, any land-use plan must normally be based on the conservation of soil fertility. Exploitation of the land for the benefit of the occupiers, resulting, as it must, in the draining of its capital resources, can have no place in a plan designed for the permanent betterment of the people dependent thereon.

After a review of the bases of classification systems the author discusses the types of classification which have been proposed, first those based on physical and chemical soil factors and then those devised according to use capabilities. Of particular interest at the present time is a short section on the estimation of the capacity of different regions to support a population.

The chapter on the use of natural vegetation as an indicator of land quality sweeps up and presents in coherent form the data of many ecologists in all parts of the world, and is of great value in indicating sources of original data.

Most of the remainder of the bulletin is a detailed review of the different systems of land classification which have been proposed by workers in all the chief countries of the world, and a consideration of the various attempts to evolve "productivity ratings" of land in terms of the experience of users. The German systems of allotting a weighted scale of points to the different factors concerned in productivity receives special attention and are considered of sufficient value to justify the reproduction of the official rating tables for arable and grassland.

In an appendix the author reproduces an outline U.S. soil-survey report which will be of interest to the student of the subject in indicating the great variety of factors to be considered in assessing the agricultural value of any region.

R. H. STOUGHTON.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

WEDNESDAY, JUNE 11.—Petroleum, Institute of, at 26 Portland Place, W.1, 5.30 p.m. A. C. Healey and L. Ivanovszky, **"Petroleum Products in the Printing Ink and Allied Industries."**

THURSDAY, JUNE 12.—Royal Society Burlington House, W.1, 4.30 p.m. Professor E. B. Verney, F.R.S., **"The Antidiuretic Hormone and the Factors which Determine its Release."**

THURSDAY, JUNE 19.—Chadwick Trust, at the Chelsea Physic Garden, Swan Walk, Chelsea, S.W.3, 4 p.m. Professor W. H. Pearsall, F.R.S., **"Water Supply and Freshwater Biology."**

Goldsmiths' Company, Foster Lane, E.C.2, 7 p.m. Professor R. S. Hutton and Dr. G. E. Gardam, **"Design and Research Centre for the Gold, Silver and Jewellery Industries."**

Royal Society, Burlington House, W.1, 4.30 p.m. (1) Sir Lawrence Bragg and J. F. Nye, **"A Dynamical Model of a Crystal Structure."** (2) B. M. Cwilong, **"Sublimation in a Wilson Chamber."**

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SIR FRANK SMITH, G.C.B., G.B.E., F.R.S.
SIR WAVELL WAKEFIELD, M.A., M.P.
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PROFESSOR C. S. GIBSON, O.B.E., M.A., SC.D., F.R.S.
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K. W. LUCKHURST, M.A.

Deputy Secretary for Special Services—Miss J. SCOTT ROGERS

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Accountant—A. G. TOYE
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Examinations Adviser—T. C. SCADDEN, B.SC.(ECON.), F.R.ECON.S.
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Auditors—MESSRS. DELOITTE, PLENDER, GRIFFITHS & CO.

Full particulars relating to the work of the Society and conditions of membership and associate membership may be obtained from the Secretary. The Annual Subscription is Three Guineas (Associates One Guinea) ; the Life Subscription Thirty Guineas. There is no Entrance Fee.

The Society's Journal, which contains full reports of the Society's Meetings, together with general articles, book reviews, etc., normally issued weekly, is published fortnightly in present circumstances. It is posted free to Fellows.

All communications for the Society should be addressed to THE SECRETARY, ROYAL SOCIETY OF ARTS, 6-8 JOHN ADAM STREET, ADELPHI, LONDON, W.C.2. *Telephone Number :* Temple Bar 8274. *Telegrams :* Praxiteles, Rand, London.

COURTAULDS
IN THE UNITED KINGDOM
No. 2 COVENTRY

IN 1904, when the old-established silk firm of Courtaulds bought the British rights to manufacture viscose rayon yarn, they selected Coventry for their factory. It was centrally situated and the womenfolk of nearby miners' families needed work; moreover, the city had an ancient textile tradition. The site purchased was an old timber yard in Foleshill Road.

Here from 1905 to 1910 the firm's chemists, technologists and workpeople fought difficulty after difficulty in spinning what later became the most successful type of rayon yarn in the world. These endeavours not only founded the Company's present-day prosperity but advanced the textile industries—and the dress standards—of every civilised country. It was from these works that a nucleus of technicians left in 1909 to found the rayon industry in the United States of America.

Today Courtaulds have four factories in Coventry and district. At Main Works viscose yarn is spun and the greater part of the Company's machinery is made. At Matlock Road and nearby Nuneaton the yarn is processed for use by the textile industries, and at Little Heath cellulose acetate rayon yarn and plastics are manufactured.

In addition to rayon for clothing, the principal war-time productions of these factories were rayon yarn for tyres and industrial fabrics, engineering parts, and cellulose acetate plastics.

About 6,600 of Courtaulds 21,000 employees work in these Warwickshire factories, which employ nearly twice as many men as women. Among the senior staff are many of the most able technicians in Britain's rayon industry. They set a high example to young people seeking a progressive career and regular employment at good pay.

The purpose of this series of statements is to inform the public of some part of the contribution made by Courtaulds' industrial enterprise to economic well-being in various districts of the United Kingdom.

Issued by Courtaulds Limited, 16 St. Martins-le-Grand, London, E.C.1.

15: FOR THOSE WHO MAY NOT KNOW

E.D.A. Explains—

THE ELECTRIC FILAMENT LAMP

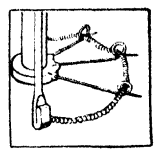
The Filament Lamp is based on the principle that certain metals can be made to glow by passing an electric current through them.

COMPONENTS

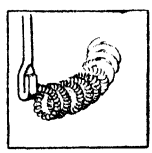
The lamp consists of a pear-shaped glass bulb fitted with a brass cap and contacts for connecting the mains. The filament wire is supported in the centre of the bulb. This filament is made of tungsten, the only metal capable of withstanding the high temperature necessary for the economic generation of light.

DEVELOPMENT

In the presence of air, even a tungsten filament will oxidise and fail at such a high temperature, so early lamps had a vacuum created inside the bulb to eliminate oxidisation. However, this caused a slow evaporation of the filament, blackening the bulb and shortening the life of the lamp. Later, more efficient lamps were produced by introducing into the bulb an inert gas, such as neon or argon, which does not oxidise the filament and retards evaporation. These are termed gas-filled lamps. The cooling effect of the gas was obviated by coiling the filament closely, so preventing free movement of the gas between the coils.

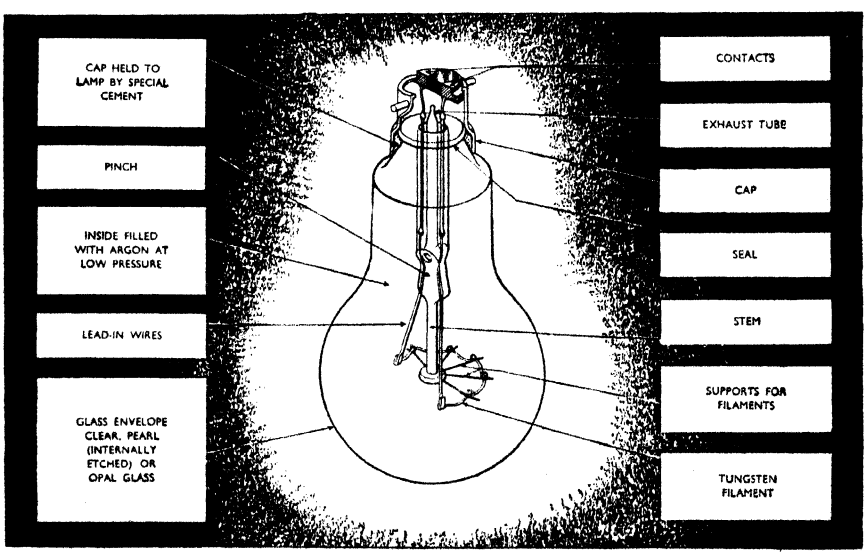


In Coiled Coil lamps, this tight filament spiral is coiled a second time, bringing a further increase in efficiency.

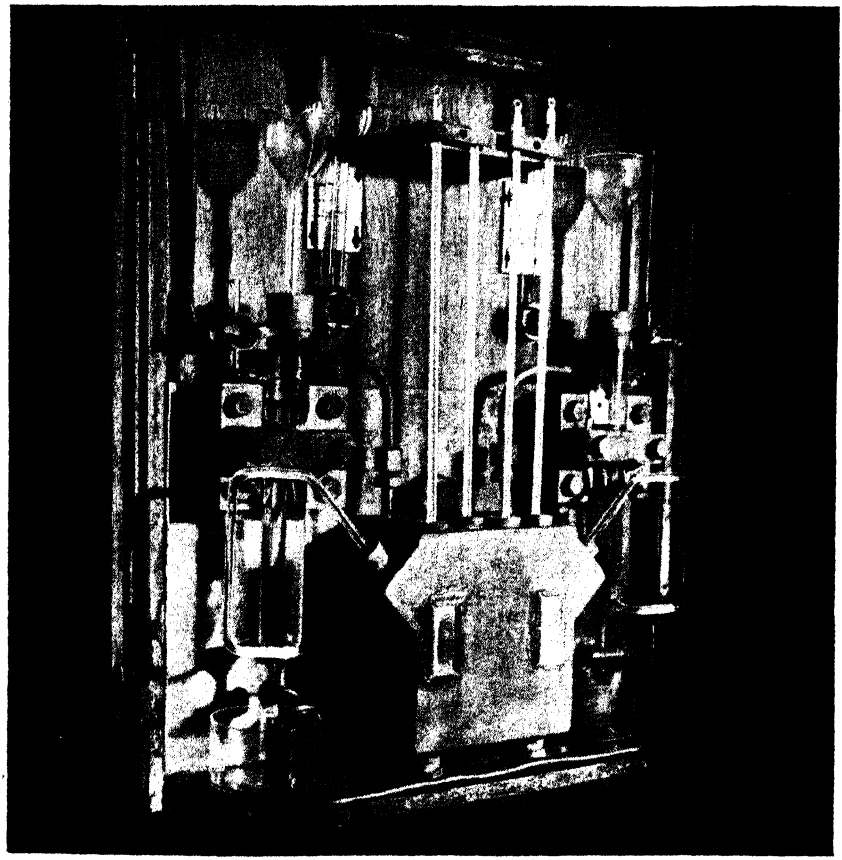


TYPES

There are two main types for general service: Clear, having transparent bulbs suitable for use with reflectors and enclosed fittings; Pearl, in which the internal bulb surface is treated with acid to provide effective diffusion and reduce glare.



Expert advice on specialised electrical subjects is always available from your local Electricity Authority.
Issued by the British Electrical Development Association, 2 Savoy Hill, London, W.C.2

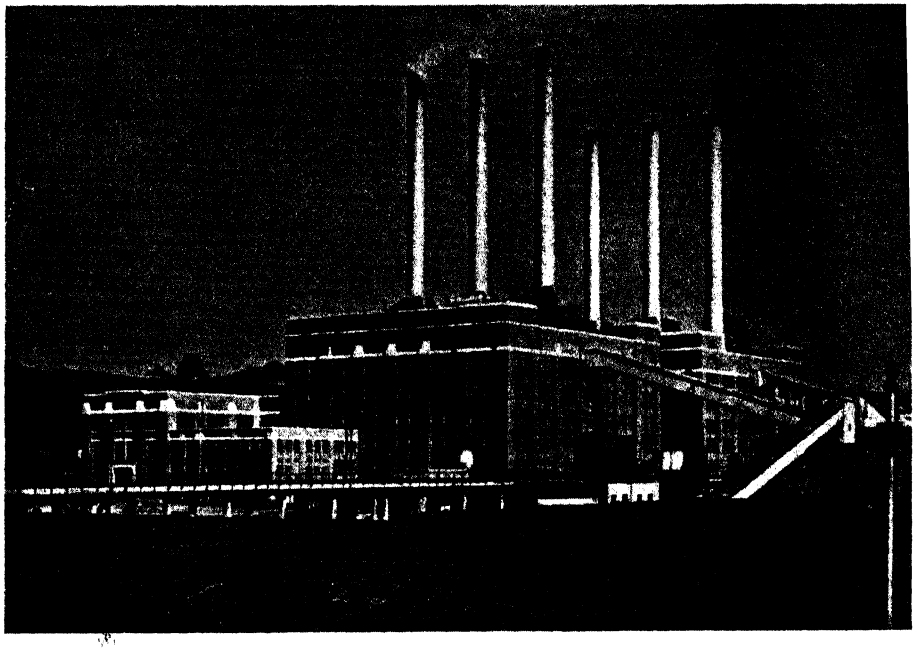


How wet is 'damp'?

How damp is your cellar? The chemist can tell you by using an instrument called a psychrometer which is illustrated above. It is used for measuring " relative humidity", that is, the amount of moisture actually in the air compared with the greatest amount that could be present at the same temperature. This psychrometer depends for its action on the fact that when strong sulphuric acid combines with water a considerable amount of heat is liberated. A measured quantity of the air under examination is passed over the bulbs of two thermometers which are graduated to one-hundredth of a degree. Strong sulphuric acid drips on to the second thermometer, and combines with any moisture which may be present. The heat produced, which is proportionate to the amount of moisture absorbed, is registered on the scale of the thermometer. By comparing the temperatures registered by the two thermometers, the relative humidity can be calculated very accurately. The psychrometer is used to discover whether any moisture is present in industrial gases when complete dryness is important. It is so accurate that it will detect as little as one part of water in a million of gas. This psychrometer is one of the most sensitive instruments used by the British chemical industry in its service to the community.

ICI

STRUCTURAL STEELWORK



Electricity Generating Station built in Steel Frame Construction

BRAITHWAITE & CO

ENGINEERS LTD

London Office : *Telephone : WHItehall 3993*

KINGS HOUSE HAYMARKET LONDON S.W.1

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4745 *FRIDAY, JUNE 20th*, 1947 Vol. xcv

FINANCIAL STATEMENTS FOR 1946.

The following statements are published in this week's *Journal* in accordance with Sec. 25 of the Society's Bye-laws :—

BALANCE SHEET, 31st December, 1946.

	£ s. d.	£ s. d.
General Fund Accounts—		
General Purposes Capital Account per annexed account (page 476)	88,844 14 8	
Dr. Cantor's Bequest : Balance at 31st December, 1945	6,356 5 0	
Life Composition Account (page 476)—		
Unexpired balance of compositions received on the basis of taking credit for such compositions over a period of 12 years from their receipt	6,123 4 5	
		101,324 4 1
Specific Fund Accounts (page 476)—		
Amount accumulated towards pensions payable under Modified Superannuation Scheme	10,019 19 6	
Provision for Rehabilitation of Building, including £500 gift in memory of the late Lord Amulree	5,377 0 7	
Industrial Art Fund Account	343 1 3	
		15,740 1 4
Liabilities—		
Creditors	2,830 3 11	
Colombo New Cathedral Competition	1,561 2 1	
Industrial Art Bursaries in suspense owing to the war	633 0 0	
Industrial Art Bursaries awarded during 1946 (balance)	425 0 0	
Cottage Fund	155 4 8	
Cadman Memorial Fund	205 17 6	
Modified Superannuation Scheme	24 9 1	
Unexpended Trust Income *less* Income over-expended (page 480)	1,475 4 7	
		7,310 1 5
		124,374 6 10
Trust Fund Accounts—		
Capital Account : Balance at 31st December, 1945	23,247 3 8	
Unexpended Income (net)	1,475 4 7	
		24,722 8 3
Carried forward		149,096 15 1

	£ s. d.	£ s. d.
General Fund Assets—		
Freehold Property, 6/8 John Adam Street—		
Cost in 1922, plus additions, *less* sales and compensation received		49,787 16 7
Leasehold Property, 67 Abbeville Road, Clapham—		
Cost in 1946	1,485 17 6	
Less Amortisation of Lease	32 13 2	
		1,453 4 4
Pictures, Books, Furniture and Fixtures (as fixed in 1919)		10,000 0 0
Investments—		
Freehold Ground Rents, at cost	10,091 14 0	
Securities (page 479)		
General (Market Value £29,828)	27,255 4 2	
Dr. Cantor's Bequest (Market Value £6,744)	6,356 5 0	
Held towards meeting pensions payable under Modified Superannuation Scheme (Market Value £7,924)	6,711 0 8	
Fund for Rehabilitation of Building (Market Value £4,916)	4,500 0 0	
		54,914 3 10
		116,155 4 9
Stocks of Stationery and Working Papers of Examinations Department at value estimated by the Society's printer	1,250 0 0	
Debtors and Payments in Advance	1,157 1 10	
Cash at Bankers	5,812 0 3	
		8,219 2 1
		124,374 6 10
Trust Fund Assets—		
Capital : Investments (page 480)	23,247 3 8	
Income due from the Society	1,475 4 7	
		24,722 8 3
Carried forward		149,096 15 1

BALANCE SHEET, 31st December, 1946—*continued.*

	£ s. d.	£ s. d.
Brought forward		149,096 15 1
Modified Superannuation Scheme—		
Balance at 31st December, 1945	1,227 19 5	
Add: Contributions and Interest received	129 9 1	
		1,357 8 6
		£150,454 3 7

Notes:

1. Credit has been taken for the whole of the subscriptions received during the year, although some relate to periods expiring after the date of the Balance Sheet, but no credit has been taken for subscriptions due but unpaid at 31st December, 1946.

2. In addition to the pensions at present being paid, the Society has undertaken in connection with the Modified Superannuation Scheme to pay pensions to two senior members of its staff.

	£ s. d.	£ s. d.
Brought forward		149,096 15 1
Modified Superannuation Scheme—		
Investments at cost (page 479) (Market Value £1,478).....	1,332 19 5	
Due from the Society.....	24 9 1	
		1,357 8 6
		£150,454 3 7

On behalf of the Council

BENNETT, *Chairman.*

WILLIAM WILL
E. MUNRO RUNTZ } *Treasurers.*

Report of the Auditors to the Council and Fellows of the Royal Society of Arts.

We have examined the above Balance Sheet dated 31st December, 1946, and have obtained all the information and explanations we have required. In our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Society's affairs according to the best of our information and the explanations given to us and as shown by the books of the Society.

5 London Wall Buildings,
London, E.C.2.
19th June, 1947.

DELOITTE, PLENDER, GRIFFITHS & CO., *Auditors.*
Chartered Accountants.

GENERAL PURPOSES CAPITAL ACCOUNT for the Year ended 31st December, 1946.

	£ s. d.	£ s. d.
Contribution under Part I, War Damage Act, 1943 deducted from Ground Rent ...	17 3	
Balance per Balance Sheet.....	88,844 14 8	
	£88,845 11 11	
Balance at 31st December, 1945		88,383 13 3
Excess of Income over Expenditure per annexed account (page 478)		461 18 8
		£88,845 11 11

LIFE COMPOSITION ACCOUNT for the Year ended 31st December, 1946.

	£ s. d.	£ s. d.
Amount taken into the Society's Income— One-twelfth of Compositions received during twelve years to date.....	1,144 3 5	
Balance per Balance Sheet.....	6,123 4 5	
	£7,267 7 10	
Balance at 31st December, 1945..... ...		5,260 10 4
Compositions received during year		2,006 17 6
		£7,267 7 10

SPECIFIC FUND ACCOUNTS for the Year ended 31st December, 1946.

Amount accumulated towards pensions payable under Modified Superannuaton Scheme—

	£ s. d.
Balance at 31st December, 1945	9,767 11 5
Add: Interest received and profit on realisation of investments (£6 5s. 3d.)	252 8 1
	£10,019 19 6

Provision for Rehabilitation of Building—

	£ s. d.
Balance at 31st December, 1945	5,242 0 7
Add: Interest on Investment	135 0 0
	£5,377 0 7

Industrial Art Fund Account—

	£ s. d.	£ s. d.
Balance at 31st December, 1945		846 3 9
Deduct · Bursaries awarded during 1946	500 0 0	
Candidates Travelling Expenses	3 2 6	
		503 2 6
		£343 1 3

INCOME AND EXPENDITURE ACCOUNT

for the Year ended 31st December, 1946.

EXPENDITURE.

1945.								
£	s.	d.		£	s.	d.	£	s. d.
			Printing and Publishing *Journal*—					
2,323	0	11	Printing and Paper	2,864	4	4		
381	13	3	Postages	504	18	0		
258	12	5	Reviews, Shorthand Reports and other expenses	329	9	6		
2,963	6	7		3,698	11	10		
39	4	8	*Less* amount charged to Trust Funds	38	5	10		
2,924	1	11					3,660	6 0
11	0	3	Library Expenses				52	11 5
124	1	7	Cost of Albert and Society's Medals and R.D.I. Expenses				127	10 0
94	10	0	Cantor Lectures				101	17 0
			Examination Expenses—					
4,535	3	6	Examiners' Fees	4,123	14	0		
2,062	17	9	Stationery and Printing	2,028	13	10		
2,847	3	9	Other Expenses	3,531	12	8		
5,705	0	0	Proportion of Salaries as below	6,234	11	11		
190	0	2	Proportion of House and Office Expenses as below	262	1	4		
15,340	5	2					16,180	13 9
14,893	18	11	Carried forward				20,122	18 2

INCOME.

1945.								
£	s.	d.		£	s.	d.	£	s. d.
9,595	13	5	Annual Subscriptions received during year				10,455	13 6
1,076	14	8	One-twelfth of Life Compositions received during twelve years to date				1,144	3 5
			Income from—					
394	18	0	Ground Rents	357	17	10		
841	17	0	General Fund Investments	884	1	0		
199	10	4	Dr. Cantor's Bequest	199	10	4		
221	13	10	Trust Funds for General Purposes	201	3	4		
24	18	0	Bank Account	3	0	6		
1,682	17	2					1,645	13 0
1,053	4	3	Sales of *Journal*, etc.,	984	9	1		
202	7	9	Advertisements in *Journal*	829	3	2		
1,255	12	0					1,813	12 3
15,899	2	7	Examination Fees	14,079	18	3		
268	4	10	Sales of Examination Papers and Advertisements	729	16	9		
16,167	7	5					14,809	15 0
75	0	0	Rent of Cellars				75	0 0
29,853	4	8	Carried forward				29,943	17 2

£ s. d.		£ s. d.	£ s. d.
18,493 18 11	Brought forward	20,122 18 2	
	Salaries, Wages and Superannuation Scheme 11,950 9 1		
11,202 10 10			
	Less **Proportion estimated to be applicable to Examinations above** 6,234 11 11		
5,705 0 0			
5,497 10 10		5,715 17 2	
	House and Office Expenses—		
367 15 9	**Rates and Insurance** 391 2 0		
73 8 10	**Repairs** 230 10 1		
	Lighting, Heating, Cleaning, Expenses of Meetings and		
612 15 0	**General Charges** 762 2 7		
	Stationery, Printing, Postages, Telephone, Audit and Accountancy and other Office		
847 2 4	**Expenses** 1,236 19 1		
1,900 1 11	2,620 13 9		
	Less **Proportion (10 per cent.) allocated to Examinations above**..... 262 1 4		
190 0 2			
1,710 1 9		2,358 12 5	
1,350 0 0	**Pensions**	1,250 0 0	
	Expenses, *less* receipts, of War Memorials Advisory Council	34 19 9	
– – –			
27,051 11 6		29,481 18 6	
	Excess of Income over Expenditure carried to General Purposes Capital Account.....	461 18 8	
2,801 13 2			
£29,853 4 8		£29,943 17 2	*£29,853 4 8*

	£ s. d.	£ s. d.
Brought forward	29,943 17 2	*29,853 4 8*
	£29,943 17 2	*£29,853 4 8*

INVESTMENTS.

31st December, 1946.

Nominal				Book Value		
SOCIETY'S				£	s.	d.
£4,845	15	0	3 per cent. Savings Bonds 1955/65	4,845	15	0
£9,839	17	7	3 per cent. Savings Bonds 1960/70	9,839	17	7
£1,592	16	0	3 per cent. Savings Bonds 1965/75	1,592	16	0
£500	0	0	3 per cent. War Stock 1955/59	499	13	5
£432	18	0	3½ per cent. War Stock 1952 or after	580	0	3
£1,000	0	0	3 per cent. Defence Bonds (issued May 22nd and November 15th, 1940)	1,000	0	0
£500	0	0	Commonwealth of Australia 4 per cent. Registered Stock 1955/70	445	0	0
£555	6	2	Commonwealth of Australia 3 per cent. Registered Stock 1955/58	538	8	5
£100	0	0	Queensland 4 per cent. Inscribed Stock 1940/50	97	0	0
£2,056	17	8	Birmingham Corporation 3½ per cent. Redeemable Stock 1957/62	2,019	16	0
£971	5	11	London County 3½ per cent. Consolidated Stock 1952/62	1,000	0	0
£1,156	1	5	Metropolitan Water Board 3 per cent. " B " Stock 1934/2003	1,000	0	0
£2,700	0	0	Southern Railway Co. 4 per cent. Redeemable Debenture Stock 1970/80	2,678	17	6
£24	0	0	New River Co. Ltd. Stock	6	0	0
	1,112		National Gas and Oil Engine Co., Ltd., Ordinary Shares of £1 each fully paid	1,112	0	0
				£27,255	4	2

Dr. CANTOR'S BEQUEST				Cost		
				£	s.	d.
£2,972	15	5	3 per cent. Savings Bonds 1955/65	2,972	15	5
£687	17	0	3 per cent. Savings Bonds 1960/70	687	18	4
£2,562	7	2	3½ per cent. War Stock 1952 or after	2,695	11	3
				£6,356	5	0

MODIFIED SUPERANNUATION SCHEME: SOCIETY'S INVESTMENTS				Cost		
				£	s.	d.
£4,102	8	0	4 per cent. Funding Stock 1960/90	4,065	2	1
£1,133	10	6	3 per cent. Funding Stock 1959/69	1,090	8	9
£1,601	10	6	3 per cent. National Defence Stock 1954/58	1,555	9	10
				£6,711	0	8

MODIFIED SUPERANNUATION SCHEME: TRUST FUND				Cost		
				£	s.	d.
£606	10	0	4 per cent. Funding Stock 1960/90	643	6	5
£402	3	7	3 per cent. Funding Stock 1959/69	403	15	5
£284	5	8	3 per cent. National Defence Stock 1954/58	285	17	7
				£1,332	19	5

FUND FOR REHABILITATION OF BUILDING				Cost		
				£	s.	d.
£4,500	0	0	3 per cent. Savings Bonds 1960/70	£4,500	0	0

TRUST FUNDS				Cost or value when received in trust					
				£	s.	d.	£	s.	d.
Dr. Aldred Trust.									
£154	8	0	3½ per cent. War Stock 1952 or after				210	17	6
Art Congress Studentship.									
£1,000	0	0	3 per cent. Defence Bonds (issued Dec. 29th 1945)	1,000	0	0			
£121	3	10	3 per cent. Savings Bonds 1960/70	121	3	10			
£391	9	6	3½ per cent. War Stock 1952 or after	398	18	7			
							1,520	2	5
R. B. Bennett Empire Prize Trust.									
£1,500	0	0	3 per cent. Savings Bonds 1960/70				1,500	0	0
Sir George Birdwood Memorial Fund.									
£734	19	9	3½ per cent. War Stock 1952 or after				674	0	0
Selwyn Brinton Trust.									
£1,000	0	0	3 per cent. Savings Bonds 1955/65				1,000	0	0
Francis Cobb Trust.									
£255	14	1	New South Wales 3½ per cent. Inscribed Stock 1930/50				250	0	0
Alfred Davies Bequest.									
£2,038	18	7	3 per cent. Savings Bonds 1960/70				2,038	18	7
Le Neve Foster Trust.									
£140	3	1	3½ per cent. Conversion Stock 1961 or after	100	0	0			
£42	2	1	3½ per cent. War Stock 1952 or after	40	0	0			
£199	14	0	Birmingham Corporation 3½ per cent. Redeemable Stock 1957/62	200	0	0			
							340	0	0
			Carried forward				£7,533	18	6

INVESTMENTS—*continued.*

TRUST FUNDS—*(continued)*	Nominal	£ s. d.
Brought forward		7,533 18 6
John Fothergill Trust.		
£272 7 6 3½ per cent. War Stock 1952 or after		374 0 0
Thomas Gray Memorial Trust.		
£9,047 18 9 3½ per cent. Conversion Stock 1961 or after		7,000 0 0
Howard Trust.		
£399 0 0 London Transport 5 per cent. "B" Stock		510 9 5
Owen Jones Memorial Trust.		
£474 2 9 3 per cent. Savings Bonds 1955/65		474 2 9
Neil Matheson McWharrie Trust.		
£350 0 0 3 per cent. Savings Bonds 1965/75		350 0 0
Dr. Mann Trust.		
£1,028 9 2 3½ per cent. War Stock 1952 or after		900 0 0
Mulready Trust.		
£111 0 9 3½ per cent. War Stock 1952 or after		109 10 1
North London Exhibition Trust.		
£134 17 0 3½ per cent. War Stock 1952 or after		184 15 0
Sir William J. Pope Memorial Fund.		
£357 4 0 3 per cent. Savings Bonds 1965/75		357 4 0
Russian Embassy Prize.		
£100 0 0 3½ per cent. War Stock 1952 or after		91 9 3
Benjamin Shaw Trust.		
£93 12 0 3½ per cent. War Stock 1952 or after		129 6 8
John Stock Trust.		
£70 4 0 3½ per cent. War Stock 1952 or after		100 0 0
Dr. Swiney's Bequest.		
Freehold Ground Rents		4,477 10 0
Trueman Wood Lecture Endowment Fund.		
£929 15 8 3½ per cent. Conversion Stock 1961 or after		654 18 0
		£23,247 3 8

TRUST INCOME AND EXPENDITURE

for the year ended 31st December, 1946.

	Unexpended Income 1st Jan. 1946. £ s. d.	Income received during year. £ s. d.	Expenditure on lectures, prizes or towards cost of *Journal* £ s. d.	Amount applied to Society's General Purposes £ s. d.	Unexpended Income carried forward 31st Dec., 1946 £ s. d.
Dr. Aldred Trust	5 8 2	5 8 2	—	—	10 16 4
Art Congress Studentship	280 5 10	47 12 10	—	—	336 18 8
R. B. Bennett Empire Prize Trust	*Dr.51 2 6*	45 0 0	—	—	*Dr. 6 2 6*
Sir George Birdwood Memorial Fund	102 18 8	25 14 8	15 15 0	—	112 18 4
Selwyn Brinton Trust	102 12 1	30 0 0	—	—	132 12 1
Francis Cobb Trust	61 10 8	8 18 10	10 0 0	—	60 9 6
Alfred Davies Bequest	—	61 3 4	—	61 3 4	—
Le Neve Foster Trust	—	12 17 8	—	—	12 17 8
John Fothergill Trust	38 4 0	9 11 0	10 0 0	—	37 15 0
Thomas Gray Memorial Trust	201 15 0	316 13 6	336 11 10	—	181 16 8
Howard Trust	36 2 11	19 19 0	—	—	56 1 11
Owen Jones Memorial Trust	176 13 6	14 4 6	—	—	190 18 0
Neil Matheson McWharrie Trust	*Dr.10 0 0*	9 5 7	—	—	*Dr. 14 5*
Dr. Mann Trust	29 18 0	36 0 0	38 19 0	—	26 19 0
Mulready Trust	50 12 0	3 17 10	—	—	54 9 10
North London Exhibition Trust	50 10 7	4 14 6	—	—	55 5 1
Sir William J. Pope Memorial Fund	5 11 8	10 10 4	10 0 0	—	6 2 0
Russian Embassy Prize	46 10 0	3 10 0	—	—	50 0 0
Benjamin Shaw Trust	5 4	3 5 8	—	—	3 11 0
John Stock Trust	30 1 3	2 9 2	—	—	32 10 5
Dr. Swiney's Bequest	80 0 0	180 0 0	—	140 0 0	120 0 0
Trueman Wood Lecture Endowment Fund	—	32 10 10	32 10 10	—	—
		£883 7 5	£453 16 8	£201 3 4	
	£1,307 19 8				1,482 1 6
	Dr.61 2 6				*Dr. 6 16 11*
	£1,246 17 2				£1,475 4 7

PRESERVATION OF ANCIENT COTTAGES FUND.

INCOME AND EXPENDITURE ACCOUNT
for the year ended 31st December, 1946.

	£	s.	d.		£	s.	d.
Taxes, Insurance and Fares	6	3	2	Donation	1	0	0
Repairs and maintenance of cottages and gardens at Drayton St. Leonard	87	10	0	Interest on Investments	47	0	6
				Rents Receivable	30	16	0
				Excess of Expenditure over Income transferred to Capital Account	14	16	8
	£93	13	2		£93	13	2

BALANCE SHEET, 31st December, 1946.

	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
Capital Account—							Cottages at Drayton St. Leonard (James Cranstoun Bequest) and Westmill—as fixed in 1932				1,000	0	0
Balance at 31st December, 1945	2,741	4	3				£500 3% Savings Bonds, 1955/65 at cost	500	0	0			
Less: Excess of Expenditure over Income as above	14	16	8				£132 3s. 6d. 3% Savings Bonds 1960/70 at cost	132	4	5			
	2,726	7	7				£556 8s. 8d. Agriculture Mortgage Corporation Ltd., 4½% Debenture Stock, 1961/91, at cost (James Cranstoun Bequest)	540	8	10			
Add: Loan Written off 31.12.41 now Recovered	50	0	0				£55 Hampstead Garden Suburb Trust Ltd., 5½% Debenture Stock at par value	55	0	0			
				2,776	7	7					1,227	13	3
							Debtors				179	6	0
							Cash at Bankers				369	8	4
				£2,776	7	7					£2,776	7	7

WILLIAM WILL
E. MUNRO RUNTZ } *Treasurers.*

Report of the Auditors to the Council and Fellows of the Royal Society of Arts.

We have examined the above Balance Sheet, dated 31st December, 1946, and have obtained all the information and explanations we have required. We have not had produced to us the Title Deeds relating to the cottage at Westmill. Subject to this remark such Balance Sheet is, in our opinion, properly drawn up so as to exhibit a true and correct view of the state of the Fund's affairs according to the best of our information and the explanations given to us, and as shown by the books of the Fund.

5 London Wall Buildings,
London, E.C.2.
19th June, 1947

DELOITTE, PLENDER, GRIFFITHS & CO., *Auditors.*
Chartered Accountants.

ANNUAL GENERAL MEETING

The Council hereby give notice that the One-hundred-and-ninety-third Annual General Meeting, for the purpose of receiving the Council's Report, and the Financial Statements for 1946, and for the election of officers, will be held in accordance with the Bye-laws, on Wednesday, June 25th, at 3 p.m., at the Society's House.

(By Order of the Council),

KENNETH WILLIAM LUCKHURST,
Secretary.

FACULTY OF ROYAL DESIGNERS FOR INDUSTRY

The following new appointments have been made to the Distinction of "Royal Designer for Industry" (R.D.I.):

James Gardner, O.B.E. (Exhibition Design).
Robert Yorke Goodden (General Industrial Design).
Ashley Eldrid Havinden (Commercial Art).

The following Honorary Royal Designers for Industry were also appointed:

Professor Alvar Aalto (Finland) (General Industrial Design).
Professor Walter Adolf Georg Gropius (General Industrial Design).
Professor Steen Ejler Rasmussen (Denmark) (General Industrial Design).

"YOUTH LOOKS AT BRITAIN" POSTER COMPETITION EXHIBITION OF DESIGNS

The judging of the designs submitted in the above competition has now been completed, and a full report, with illustrations of winning designs, will be published in the next issue of the *Journal*. In the meantime, Fellows are informed that prize-winners' and other selected designs will be on exhibition at the Travel Association, 66 Whitcomb Street, Leicester Square, London, W.C.2, from Tuesday, June 24th, to Monday, June 30th, inclusive, Sunday excepted. The hours of admission will be 10 a.m. to 7 p.m. daily.

INDUSTRIAL ART BURSARIES COMPETITION, 1947

The Council have decided to continue in 1947 the Industrial Art Bursaries Competition, which was suspended in 1942 owing to the call-up of students, and resumed in 1946. One Scholarship of the value of £150 is being offered in each of the following industries: Furnishing Textiles, Leather Goods, Wallpaper, and Open-Close Stoves. The Council have also agreed to make one additional award not exceeding £150 if two candidates in any group are thought to be of equal merit. The competition is open to *bona fide* art students between the ages of 16 and 25. The age limit may be extended in the case of candidates whose studies have been interrupted by war service. The scholarships are for the purpose of helping to maintain promising designers while attending an approved College or Institution, or while gaining technical or other experience in an approved factory, studio or retail establishment, or for part-time instruction in a school and part in another establishment. The closing date for entries is June 30th.

The following Juries have been appointed:

Furnishing Textiles.—Mr. E. W. Goodale, C.B.E., M.C. (*Chairman*), Mr. Allan Walton, R.D.I., Mr. O. M. Power and Mr. M. Gardiner Morris.

Leather Goods.—Mr. F. H. Andrews, O.B.E. (*Chairman*), Mr. Milner Gray, R.D.I., Mr. J. W. Waterer and Mr. G. Parsons.

Wallpaper.—Mr. Basil Ionides, F.R.I.B.A. (*Chairman*), Mr. Laurence Irving, O.B.E., R.D.I., Mr. Alan V. Sugden, J.P., and Mr. Henry G. Dowling, P.I.B.D.

Open-Close Stoves.—Mr. A. C. Bossom, F.R.I.B.A., M.P. (*Chairman*), Mr. Wells Coates, O.B.E., R.D.I., F.R.I.B.A., Mr. F. Bowen and Mr. A. C. Franklyn (both nominated by the Coal Utilisation Joint Council).

The competition has the support of the Ministry of Education, the Council of Industrial Design, the Federation of British Industries, the Society of Industrial Artists, and the Design and Industries Association. Representatives of these bodies are members of the permanent Bursaries Board which has been set up by the Society and which also includes representatives of the Council of the Society and representatives of the manufacturing and distributing sides of industry. Further details and conditions of entry may be obtained on application to the Secretary.

MEETING OF COUNCIL

A meeting of Council was held on Monday, June 9th, 1947. Present: Lord Bennett (in the Chair); Lord Aberconway; Mr. F. H. Andrews; Mr. A. C. Bossom; Sir Frank Brown; Major W. H. Cadman; Sir Edward Crowe; Professor C. S. Gibson; Mr. E. W. Goodale; Miss Caroline Haslett; Dr. R. W. Holland; Sir Harry Lindsay; Sir Henry McMahon; Mr. G. K. Menzies; Mr. J. A. Milne; Mr. Keith Murray; Mr. J. W. Ramsbottom; Mr. E. M. Rich; Mr. E. Munro Runtz; Mr. William Will and Miss Anna Zinkeisen, with Mr. K. W. Luckhurst (Secretary).

The following candidates were duly elected Fellows of the Society:

Adams, Charles Sydney, B.A., Manchester.
Akhurst, James Henry, New Barnet, Herts.
Ayre, Major Amos Lowrey, R.E., Rangoon, Burma.
Budgen, Edward Ralph, Cardiff, Glamorgan.
Chen Yuan, Professor, London.
Colquhoun, James Clifton, London.
Cullen, Lieut.-Colonel Alexander, O.B.E., Inverness.
d'Andrea, Albert Philip, New York, U.S.A.
Douglas, Robert Bell, M.Sc., Quebec, Canada.
Fawcett, Richard Alexander, Ilkley, Yorkshire.
Fennah, Captain Robinson Golding, Salford, Lancs.
Fitzmaurice, Robert, B.Sc., London.
Hartley, Arthur Clifford, C.B.E., B.Sc., West Byfleet, Surrey.
Hilton, Arthur Cyril, Manchester.
Hobson, Geoffrey D., M.V.O., London.
Hooker, Dr. Stanley George, B.Sc., Duffield, Nr. Derby.
Jones, David Brynmor, Radlett, Herts.
Lines, Roland Charles, Solihull, Warwickshire.
Lydall, Francis, B.A., B.Sc., Weybridge, Surrey.
Lythgoe, Joseph, Hawera, New Zealand.
Macdonald, Professor George, M.D., London.
Mallett, Edward, D.Sc., London.
Medworth, Frank Charles, Sydney, Australia.
Neal, Gilbert Henry, Gold Coast Colony, B.W.A.

Nelson, Sir George Horatio, Stafford.
Newton, Sir Basil Cochrane, K.C.M.G., London.
Phillips, Vice-Admiral Sir Henry Clarmont, K.B.E., C.B., Woodmancote, Hants.
Power, Dennis Arthur, New Barnet, Herts.
Rao, Vakethur Rathnaker, London.
Raynor, Geoffrey Vincent, M.A., B.SC., D.PHIL., Birmingham.
Robinson, Arthur, Preston, Lancs.
Saunders, Stanley George, London.
Seltman, Charles Theodore, M.A., Cambridge.
Shrewsbury, Professor John Findlay Drew, M.D., D.P.H., Birmingham.
Simon, Professor Franz Eugen, C.B.E., M.A., PH.D., F.R.S., Oxford.
Skeete, Herbert Lingard, Curaçao, N.W.I.
Slater, Victor Wallace, B.SC., Luton, Beds.
Sneddon, James Galbraith, Glasgow.
Tubb, Leslie Francis James, West Harrow, Middlesex.
Walker, William Petty, B.A., Toronto, Canada.
Weatherall, Arthur, Keighley, Yorks.
Weeks, Ernest Poole, M.A., D.LITT., D.PHIL., Ottawa, Canada.
Wilson, Sir Horace, G.C.B., G.C.M.G., C.B.E., Boscombe, Bournemouth.

The Centenary of the grant of the Society's Charter, which fell on the day following the meeting of Council, was referred to, and it was decided to arrange for the parchment to be framed and publicly exhibited.

Three appointments were made to the Distinction of Royal Designer for Industry and three to the Honorary Distinction (see p. 482).

The resignation of the Deputy Secretary for Special Services was announced.

It was decided that Cantor (and similar) lectures should next session commence at 4.30 p.m.

The draft Report of the Council for 1946–47 for submission to the Annual General Meeting was considered, amended, and approved.

A quantity of formal and financial business was transacted.

THOMAS GRAY MEMORIAL TRUST

The Society has decided to revive the award, under the Thomas Gray Memorial Trust, of a silver medal to the candidate obtaining the highest mark during the year in the examination for the Ministry of Transport Extra Master Certificate. The medal for 1946 has been awarded to Captain James Howard Williams, of Blackpool.

PROGRAMME OF MEETINGS FOR THE 194th SESSION

The Council will proceed in June to arrange the programme for the forthcoming 194th Session, and any suggestions from Fellows, either as to subjects or lecturers, will be welcomed by the Secretary.

THE FORESTS AND FOREST RESOURCES OF INDIA

By Sir HERBERT HOWARD

Secretary, Imperial Agricultural Bureaux and formerly Inspector-General of Forests to the Government of India, and President, Forest Research Institute

India and Burma Section, Thursday, February 6th, 1947

E. P. STEBBING, M.A., *Professor of Forestry, Edinburgh University, in the Chair*

THE CHAIRMAN: It is my pleasure this afternoon to introduce to you our lecturer,

Sir Herbert Howard, who is going to discuss the forests of India. He has had a very distinguished career in India, occupying several important posts ending up with the Inspector-Generalship of Forests from which he retired last year. In introducing the lecturer I realise that the Chairman probably knows something about the subject and often takes the opportunity to air his own views. I have strong ideas on that subject, having often suffered thereby, so I do not propose to air any of *my* views. I might, however, just say one thing which I do not think is in the paper, and that is that the Indian Forest Service started away back in 1864 and owes its origin to two men of very wide vision; one was the first Secretary of State for India, Sir Charles Wood, and the other was the Viceroy, Lord Elgin. Two despatches passed between the Viceroy and Secretary of State in 1862 and it was the ideas expressed therein about the want of management of the forests, what was happening to them, and the necessity of conserving them which gave rise to the Indian Forest Service in 1864.

Sir HERBERT HOWARD then read the following paper:

GENERAL DESCRIPTION

In any given country the vegetation—and that means here the forests and forest resources—depends on the temperature and rainfall, the soil and past treatment. With a given temperature, moisture (and ultimately that is rainfall) is the main general deciding factor of the type of forest produced. Important though the soil is, it only influences the type of forest within the limits set by the climate, which is determined largely by temperature and rainfall. Whatever the general type may be in a given locality as determined by the interaction of temperature, rainfall and soil, the past treatment will decide the actual state of the forest.

India, including both British India and the Indian States, presents practically all variations of climate. Temperatures rise as high as 120 degrees in the shade for considerable periods, for example, in places like Multan or Jacobabad, while there are regions of perpetual snow above about 16,000 ft. in the Himalayas. Rainfall varies from under 5 in. per annum in places in the Sind desert to the highest rainfall in the world at Cherrapunji, with an average of 450 in. per annum and a record of over 900 in. Without going into details of all the many varieties of soil in India, it may be said that they include all types from pure sand to the stiffest clay. With such a wide range of conditions, the forests of India naturally contain a very large variety, both of types and species, sufficient in kind to make its forest resources capable of supplying all the ordinary needs of the population.

But apart from the influence of altitude in lowering temperature, which for practical purposes means the mountains on the Western Border, the Himalayas and the Nilgiris, India as a whole is mostly tropical. The result of all this is that for practical purposes the distribution of types of forests over most of the area of India is governed by the rainfall, influenced locally by soil.

If a rainfall map of India be examined it will be seen that, very roughly speaking, the rainfall is lowest in the west in Sind and the Punjab, increasing as one proceeds eastwards towards Bengal and Assam. Beginning with a low rainfall of under 5 in. in Sind itself, it rises to considerably more than 100 in. in the extreme east. On the west coast of Madras there is a strip of very heavy rainfall between the coast and the Nilgiris with over 200 in., decreasing rapidly as one proceeds eastwards till the rainfall rises again owing to the influence of the north-east monsoon (Fig. 1).

It is not possible in a paper of this length to give all the various types of forest that exist. At best only general indications can be given.

Approximately the types of forest follow those variations in rainfall. Thus in the extreme west in the Sind desert there is practically no vegetation except scattered trees of *Prosopis spicigera*, *Capparis aphylla*, *Salvadora oleoides*, *Salvadora persica*, *Tamarix articulata*, etc.

Slightly to the east of this is a belt of tropical thorn forest with various species such as *Prosopis spicigera*, *Capparis aphylla*, *Balanites roxburghii*, *Zizyphus jujuba*, *Salvadora oleoides*, *Acacia leucophloea*, *Acacia arabica*, *Carissa spinarum*, *Adhatoda vasica*, etc.

Further east again is a large area of dry deciduous forest with such species as *Anogeissus latifolia*, *Acacia catechu*, *Buchanania latifolia*, *Terminalia tomentosa*, *Bauhinia variegator*, *Kydia calycina*, *Shorea robusta* (*sal*), *Boswellia serrata*, *Phyllanthus emblica*, *Grewia vestita*, *Ougenia dalbergioiodes*, *Dendrocalamus strictus* (bamboo), *Stereospermum suaveolens*, *Bombax malabaricum*, *Lannea grandis*, *Garuga pinnata*, *Hymenodictyon excelsum*, *Terminalia belerica*, *Diospyros melanoxylon*, *Adina cordifolia*, *Stephygyne parviflora*, *Pterocarpus marsupium*, *Terminalia chebula*, *Dalbergia sissoo* and many others. The *sal* occurs in large gregerious masses.

East of this again is a moist deciduous forest containing principally *Shorea robusta* in gregarious masses and forming the most valuable forests of North India, and further east again a tropical semi-evergreen and wet evergreen forest with such species as *Dipterocarpus pilosus*, *Artocarpus chaplasha*, *Artocarpus integrifolia*, *Shorea assamica*, *Cinnamomum cecicodaphne*, *Dysoxylon binectariferum*, *Altingia excelsa*, *Messua ferrea*, *Eugenia* spp., *Sterculia alata*, *Michelia champaca*, *Amoora wallichii*, *Garcinia* spp., *Aquilaria agallocha*, *Cedrela toona*, *Ficus* spp., *Phoebe hainesiana*, *Vatica lanceaefolia*, *Dendrocalamus hamiltonii*, *Teinostachyum dullooa*, *Bambusa pallida*, *Terminalia myriocarpa*, *Bischoffia javanica*.

The boundaries of these zones do not run north and south, but are roughly triangular with the apex of the triangle to the east. Thus the tropical dry deciduous extends as far west as longitude 72 in the south and 76 in the north, but between these two the tropical dry thorn forest extends nearly as far east as longitude 80, while the tropical dry deciduous itself extends in a long tongue right down the Ganges almost to longitude 88 and in another tongue below the Central Provinces as far as longitude 84. In other words, to repeat, the forest distribution follows the rainfall distribution.

There are exceptions. Thus all through the Gangetic plain the well-defined cane brakes fringe many of the more sluggish streams. In Bombay and Hyderabad there is a belt of tropical dry deciduous and tropical thorn forest in a temperature and rainfall which would ordinarily produce a moister type of forest, but which is caused by the exceedingly dry type of soil which occurs there. Right down the west coast from Bombay to Cape Comorin is a belt of tropical wet evergreen and tropical semi-evergreen, and another belt of tropical wet evergreen in the east of Assam towards the Burmese border. There is also the mangrove forest in the Sundarbans.

The Himalayas have a zoning of their own running from, roughly, west to east in a semi-circle, the zoning depending mainly on altitude, though rainfall plays an important part as one proceeds east. Thus, all along the lower Himalayas occur the

sub-tropical pine forests of *Pinus longifolia*, above those the moist temperate forests of deodar, blue pine (*Pinus excelsa*), silver fir and spruce, above those are the dry temperate oak forests and above those again the alpine forests. In the eastern Himalayas the rainfall alters this so that in the lower altitude occur the sub-tropical wet forests and higher up the wet temperate forests.

This description does not give any detail of the south Indian forests which contain many valuable species. Worth mentioning are the teak forests of Malabar, Bombay

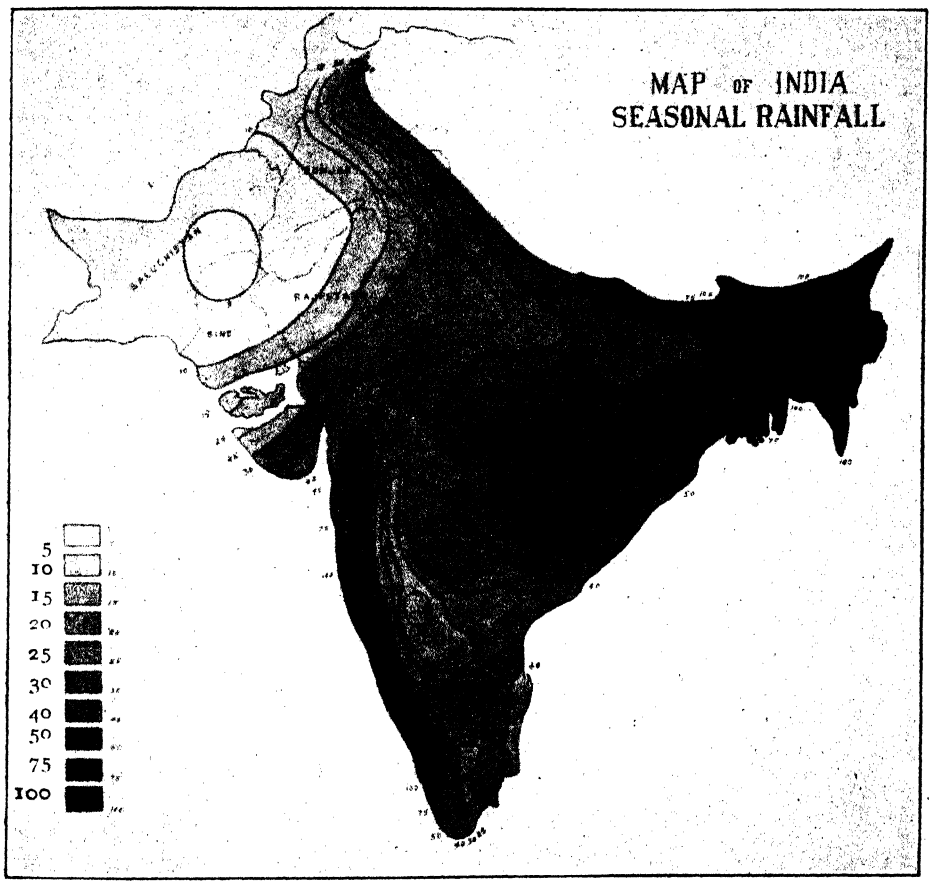


FIG. 1.—*Rainfall in India, inches per annum*

and the Central Provinces, the valuable *Hopea* forests, the eucalyptus forests of the Nilgiris, the sandalwood areas and the peculiar dry evergreen with such species as *Mimusops*, *Diospyros ebenum*, *Strycnos nux vomica*, etc.

The above is a very brief description of the types of forests and the species which occur; but, brief though it is, it does bring out the fact that every type exists, from wet evergreen to desert and from tropical forest to alpine.

FOREST ORGANISATION AND MANAGEMENT

While the forest resources of India are more than adequate in variety they are no

longer adequate in quantity. Many uncultivated parts of India at present are almost devoid of tree growth or are covered with a useless scrub where at one time were magnificent forests. There are records which show that the Gangetic plain was once a vast forest with an equable climate. At the present day the forest is in scattered patches and the climate is anything but equable. The Emperor Babar hunted rhinoceros in *sal* forest where at present there are only the Etawah ravines. In the Gorakhpur district there are only patches of *sal* forest remaining. Even those patches only remain by a lucky chance. To open up the country, the Government granted lands to settlers on condition that they cleared the jungle. If the jungle was not cleared by a certain time the area was to revert to Government. The few patches of *sal* forest which remain in the Gorakhpur district are those areas which the grantees failed to convert to agricultural land. Surrounded by a dense population with an unlimited demand for all forest produce, they are to-day the most valuable forests in India, where even the sweepings of the leaves which remain after a felling can be sold at a profit. The ruin of the forests was so extensive that Government was forced to take notice of it. Somewhere about 1865 a Forest Department was formed. Its task was to rescue the comparatively few remaining forests, preserve them, nurse them back to health and put them under systematic forest management.

Forest Policy

The Government of India, on the advice of its experts, adopted a forest policy which even to-day stands as an example and has formed the basis of policies in other parts of the Empire. I have no record of exactly when this policy was first reduced to writing but, at any rate, in 1894 in Circular 22 F, dated October 19, 1894, the policy, which in fact had guided the Forest Department since its inception, was issued formally. That policy classifies Government forests into:

(*a*) those necessary on climatic or physical grounds (prevention of floods, erosion or desiccation), *i.e.*, protection forests;
(*b*) timber forests (principally for timber supplies and revenue);
(*c*) minor forests (principally to supply local needs), and
(*d*) pasture forests.

Without going into the details of the whole forest policy, its outstanding principles may be summed up as:

(*a*) the preservation of the climatic and physical conditions of the country comes before everything else (even before agriculture);
(*b*) the preservation of the minimum amount of forest necessary for the general well-being of the country is second only to (*a*) above.

After the above two conditions are fulfilled then:

(*c*) agriculture comes before forestry;
(*d*) the satisfaction of the wants of the local population free or at non-competitive rates comes before revenue, and
(*e*) after all the above are satisfied, the realisation of revenue to the greatest possible extent is permitted.

Nothing is actually said in the written policy about the principle of the sustained annual yield, that is to say, that the annual amount of forest produce does not decrease from year to year, that it is approximately equal each year, and that the

yearly amount rises gradually until the maximum possible yield from the soil is obtained. But Government has always recognised the principle—for instance, in its F. 56-3/35-F. dated January 8, 1936, Government said:

> "It is inadvisable to permit a departure from the principle of sustained annual yield which has been the fundamental principle of Indian forestry since the foundation of the Forest Department in India".



(Reproduced by courtesy of the Government of India Press)

FIG. 2.—*Government Forests in British India*

THE FOREST ACT

To give the necessary power to enforce a forest policy, legislation is necessary. The Indian Forest Act dates from 1878 and was revised as Act No. 16 of 1927. The present Forest Acts of the various provinces all base their provisions on that Act. Among other things it legislated in Chapter V for the control of lands not the property of Government and enabled Government to assume the management of private forests in cases of necessity. There are, however, faults in the Act, because

such compulsory management could only be applied to what might be called protection forests, and by the time conditions were such that the Act could be applied, it was often too late to do any real good.

Area and Resources

In the first part of this paper it was shown that there was great variety in India's forest resources. But the actual area of forest had been very greatly diminished by the time the Forest Service was created. Before the war, after over seventy years of scientific management, the reserved forests were beginning to give a yield proportionate to their area on the more valuable tracts, though there were still large parts where the yield was very much below what it should have been. The area of India including all Indian States, Agencies, etc., is about 1½ million square miles. The area of British India, excluding States and Agencies, is in round figures 858,000 square miles. The rest of this paper deals really with British India, because the requisite details are not available for the States. Much that is written, however, applies equally to the States; but, as a whole, the forests there are less well managed and less cared for than those of British India. Of the total area in British India of 858,000 square miles, about 122,000 square miles are Government forests, though only about 106,000 square miles are under the control of the Forest Department. Even of these 106,000 square miles something like 31,000 square miles are what are called "unclassed" forests and about 16,000 square miles are "protected" forests, leaving only 75,000 square miles of "reserved" forests. Thus it will be seen that even taking all the Government forests, those under the Forest Department and those under the Revenue Department, the area of forest covers 14 per cent. of the total area, of which only about 9 per cent. is really merchantable forest, though the latter figure is not very reliable. In addition to the above 14 per cent., there are perhaps another 53,000 square miles of private forests, making the total forest area about 20 per cent. of the land area of British India.

Although 20 per cent. is probably a fair proportion of land under forest to fulfil the first two principles of India's forest policy, namely that necessary on climatic and physical grounds and for the general well-being of the country, it is really only 20 per cent. in name. The private forests of India have been over-felled, and have been gradually depleted for many years. This process has been accelerated during the war, and, unless something is done, these forests will soon disappear completely. Even now they are not effective forests from the protective point of view, and do very little to prevent floods and consequent erosion or to prevent desiccation in the dryer areas of Rajputana.

Yields

The total yield of the forests of India in the period just preceding the war was approximately 62 million cubic feet of timber and about 210 million cubic feet of fuel a year.

It would be confusing to attempt to give any idea of all the species which comprised this yield, but a few of the important ones which may be named are *Acacia arabica* (*babul* or *kikar*), a strong durable wood, very popular for all agricultural implements; *Bombax malabaricum* (*semal*), used for a large variety of ordinary

goods, like matchboxes, match splints, packing cases and in plywood for rather poor tea boxes; *Cedrus deodara* (deodar), a fine railway sleeper wood; *Dalbergia sissoo* (sissoo), an excellent cabinet and furniture wood and also a good constructional timber; *Morus alba* (mulberry), excellent for sports goods; *Pinus longifolia* (chir pine), a good railway sleeper wood when treated and yielding a valuable resin; *Shorea robusta* (*sal*), the most used and best untreated sleeper wood in India—also



(*Reproduced by courtesy of the Government of India Press*)

FIG. 3.—*Forest Areas under regular management in India (including Indian States)*

an excellent constructional wood for rafters, piles, bridging, etc.; *Tectona grandis* (teak), too well known to need description, and many others.

The woods of India cover almost every commercial use, aeroplanes, agricultural implements, axe and tool handles, bentwood articles, boat and ship building, bobbins, boot lasts, brushes, buildings, carts and carriages, construction and general joinery work, cooperage, electric transmission poles, engraving and printing blocks, floor blocks (parquet), furniture, cabinet making and panelling, marine piles and

harbour work, match splints and boxes, mathematical instruments, mine work and pit props, motor bodies, musical instruments, packing cases and boxes, pencils and penholders, picker arms, picture framing, plywood and lamin boards, railway carriages, railway keys and brake blocks, railway sleepers, rifle parts and gun stocks, road paving blocks, shuttles, sports goods, tent poles and tent pegs, turnery, umbrella handles and walking sticks, etc.

Imports of timber into India were small, on the other hand there were practically no exports. I have few figures, but just before the war India imported about 185,000 cubic tons of timber of which, however, 160,000 tons was teak from Burma, an import which, with the rapidly-increasing teak plantations in India, will eventually cease.

Despite the import figures it is not true to say that the forests of India supply the demands of India, but it is probably true to say that the forests of India supply the *urban and more valuable demands* for timber in India. I mean that the towns, the big manufacturers, factories, railway lines, bridges, etc., in fact, all the more valuable uses of timber, were fairly adequately supplied before the war. Naturally also, the less valuable demands of villagers living in close proximity to the forests were fully supplied.

Not only were all these normal demands adequately supplied, but the tremendous demands made on Indian forests by the Supply Department during the war were fully met, though not without some difficulty. The demands, through the Supply Department, for war supplies alone rose to approximately a million tons a year, say 50 million cubic feet or, in other words, not very different from the ordinary annual yield of Indian forests. While various other demands were drastically cut, the fact remains that the last figures which I have show an annual timber cut of nearly 90 per cent. above normal.

So effective had been scientific forestry in the preceding seventy-five years that this excessive demand was met without material damage to the forests. It is of course perfectly true that much of the excess fell on the best trees in the best areas and, from the revenue-producing point of view, the forests have been temporarily damaged for a few years. But from the point of view of the general use of the land and the good of the country, the forests have not been damaged seriously as forests. Part of the excess yield came from the use of inferior species, not previously considered of any value, the excessive demand enabled thinnings to be made which would have been too expensive in normal times. Though nobody would pretend that the war fellings had not been harmful, they were not an unmitigated evil. Their harm is only temporary and only from the revenue-producing point of view has any harm been done at all. Moreover, the final effects of the past eighty years of scientific management have not yet been fully felt. It will not be for another twenty years, or a little more, that the first forest regenerated under the care of the Forest Department will attain maturity, and the increase in yield which will then take place will be something far greater than anything which has been obtained in the past.

Distribution

So far this paper has shown the great variety of the timber in India's forests, and it has indicated that the ultimate effective forest area, of perhaps 10 to 15 per cent.,

did in fact supply the general demand for timber in India. But those were the general demands of town dwellers, for building construction, general constructional timber, railway sleepers, etc. Big and important though they are, they all deal with the more valuable classes of timber. A railway sleeper, comparatively speaking, is a fairly expensive item, at any rate, it is expensive compared with the price of fuel. Even fuel that is sold to and used by town dwellers, or by factories as



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FIG. 4.—*Areas of Forest and Open Scrub in India (including the Indian States)*

a substitute for coal, can be sold at a much higher price than the ordinary cultivator, for instance, could afford to pay for fuel or for the small timber that he needs for his house or for his agricultural implements.

India, however, is not a land of towns. It is a land of villages. It is not yet a land of industry but a land of agriculture. It is not a country of the rich but a country of the poor and hungry.

If a map of the forests of India be examined, it will be found that except for the Central Provinces, the Bombay Presidency and the Madras Presidency, roughly speaking south of a line from the Gulf of Cambay to Calcutta, the forests under

the Forest Department consist of a narrow strip in the north in and along the foot of the Himalayas, the forests in the east of Assam, the Sunderbans, and a few odd patches down the Indus, in the south of the United Provinces and in Bihar and Orissa (see Figs. 2 and 3). Though the data are insufficient to deal here with the forests of Indian States in detail, it will be found that a large part of them fall somewhere within this area, including the immense tract of Rajputana, and over those areas the forests are small, scattered and deteriorating. Over all this immense area the vast village population cannot get sufficient wood for its needs. The villagers have no wood from which to make their houses, the pasture is too scanty to feed their miserable cattle, the people are poor and hungry, and their standard of living is deplorable.

It is here that the poor distribution of the forests of India does so much harm. Although in the Himalayas and, until the war in many of the plains—forests as well, large quantities of good fuel and small poles were left to rot on the ground, the villager over all the plains of North India could not get the fuel and small timber that he needed, because the cost of carriage, even if the quantity had been available, would have made delivery impossible. In fact, if the demand had been effective, the forest area would have been found far too small to supply it, and the only reason fuel was left to rot in the forests was because the demand was not effective.

The result of this is that the villagers, unable to obtain any other form of fuel, burn cow dung, and thus deprive the soil of the only source of manure which is available and which they understand. It has been calculated that in British India the cattle population is over 200 million and the cow dung of perhaps 85 million is burnt. This probably represents 60 million tons of dry manure per year, capable of producing somewhere about 345,000 tons of nitrogen, or sufficient to manure 13 per cent. of the whole of India's cultivation.

These astronomical figures mean little and no one would claim that they are accurate. But they are useful merely to show the magnitude of the destruction involved. If any method could be found to avoid this destruction, it could alter the whole economy of India's villages, whether the real figure represents the adequate manuring of 13 per cent. of the total cultivated area or whether it represents very much less. Instead of the present burning of cow dung, inadequately manured fields, poor yields, poor pastures and poor cattle and a general downward spiral of poverty, there would be manure for the crops, better yields, increased food, better cattle and a general upward spiral of prosperity.

The forest problem of India is not the supply of the more expensive forms of timber, but the adequate supply to the villager on his doorstep of fuel and small timber to avoid this burning of cow dung.

The provision of this supply is the crux of the problem of the forest resources of India. Adequate though they are in variety, in quality and even in quantity for the better demand, they completely fail in the more important matter of supplying village demand.

Future Forest Policy

This is the main problem which the post-war Forest Policy of India proposes to

tackle. Again taking British India alone, because adequate figures only exist for British India, it will be remembered that there are about 106,000 square miles of forests under the forests department and perhaps another 50,000 square miles of private forests, which latter are often little more than scrub. There are also roughly 145,000 square miles of what is cultivable waste and another 145,000 square miles of uncultivable waste. The forest area of 106,000 square miles represents about 13 per cent. of the total land area. Probably, if 25 per cent. of the total area were covered with forest, it would provide sufficient for the whole needs of the population, assuming that there was proper distribution.

That is the ultimate aim of the future policy, namely, to double the existing area of the effective forest lands. The policy has been generally accepted both by the Central Government and by the various provinces, and actually is in process of being carried out. It is a tremendous undertaking, however, and means doubling the forest staff to start with, for which steps have already been taken by more than doubling the educational facilities at Dehra Dun.

The plan has been criticised on various grounds, for instance:

(*a*) that the uncultivable waste cannot be cultivated and cannot even grow forest crops;

(*b*) that the waste cannot be used for forest crops or there would be no grazing for the cattle;

(*c*) that even if the villager were provided with fuel, he would still burn his cow dung, as, in fact, he does in some parts of India where there is plenty of fuel.

These criticisms, fortunately, have not so far prevented the policy being given a trial. Nor, in my opinion, are the criticisms well founded. The total area of forest land required, even to double the area of forest, is a little over 100,000 square miles. To provide that there are over 50,000 square miles of actual private forests, although it is not effective forest, and it is in process of disappearing. To prevent such disappearance, certain Governments have already introduced legislation. The only completed Act I have seen is the Bengal Private Forests Act, but there are several others under consideration, like the Chota Nagpur Private Forests Bill, the United Provinces Rural Development Bill, a revision in the North-West Frontier Provinces of the Rules for Village Forests, and so on. There is no question of whether this 50,000 square miles could grow forests, because it does grow forests of a sort, but it is not sufficiently well distributed to solve the whole problem. Even this 50,000 square miles would give the Forest Department sufficient work to keep it going for a generation. Of the 145,000 square miles of uncultivable waste, it is perfectly true that a large area could not grow trees, but a proportion of it could, for it must be remembered that it was classified from the agricultural point of view and not from the forest point of view. Of the cultivable waste of 145,000 square miles, a large proportion could grow trees. Here the objection is that the land is needed for grazing. But, properly managed, the yield for grazing would not be decreased by the introduction of forest management, but increased. The proposal is not necessarily to grow long rotation forests. On the contrary, the vast majority of the area would be under a short rotation of fifteen or twenty years, simply to provide small timber and fuel. And out of the total of 340,000 square miles only about 100,000 square miles has to be found (see Fig. 4).

FLOODS, EROSION AND DESICCATION

The extent of this problem is too well known in India to need any elaboration here. But while the problem of floods and erosion has received a great deal of publicity in recent years, the problem of desiccation has not. It may not be generally realised, for instance, that the rainfall in a place like Jaipur, which is approaching desert conditions, is not very different from the rainfall in London. It is definitely part of the future policy to afforest the desert. Naturally, the first attempts would not be made in the dryest areas. But even if areas down to a 10-in. rainfall could be afforested, it would have solved some of the worst of the problem. It can be done *and it has been done. Prosopis spicigera* grows indigenously in areas with even less than a 10-in. rainfall. It has a very close relative from Mexico, the mesquite, *Prosopis juliflora*, which was introduced successfully into India many years ago, and which can be found growing in pure sand and spreading naturally in areas to the west of Jodhpur in a rainfall of 10 in. The tree is not eaten by goats, it is particularly hardy, will grow even in saline soils and, in fact, has all the makings of a pest, but even a pest in the desert would be an advantage. Although not even the goat will eat the tree, its pods are greedily devoured not only by goats but by cattle. It produces two crops of pods a year, and, if the desert parts of Sind and Rajputana could only be covered by the mesquite, the terrible cattle famines would be a thing of the past. In addition, while forests may not increase rainfall, they most certainly act as a sponge, hold up the rain that does fall, prevent evaporation (which, by the way, is 7½ ft. per year from a free surface in Jodhpur), prevent floods and stop erosion.

I have not mentioned in this short paper anything about the Forest Research Institute at Dehra Dun, probably as fine a forest research institute as any in the world. I have said nothing of the very fine forest education given at the Dehra Dun colleges, nor have I mentioned those other forest products which may be even more valuable than timber, like gums, resins, tanning materials, dyes, drugs, etc. The value of these other products was about £280,000 before the war out of a total revenue of about £2½ millions. The revenue has reached many times that figure during the war.

And lastly, I have not spoken of the more ordinary aims of the future forest policy of India, namely to continue the 1894 policy, to revise, as quickly as possible all working plans, which had necessarily to be departed from during the war, temporarily to reduce yields so as to save and replace the overdraft drawn from the forest capital during the war, to speed up regeneration where it was perforce neglected during the war, and, in fact, generally to clean up the war mess. Those are all routine matters with any properly constituted forest department.

DISCUSSION

Mr. C. E. SIMMONS: Sir Herbert Howard mentioned the question of forest education in India. In spite of the fact that up to quite recently Sir Herbert had been combining the two posts of Inspector-General of Forests and President of the Forest Research Institute and Colleges, he devoted a great deal of his time in going round the Indian States and impressing upon them the seriousness of the problem of getting the fuel, which the villager must have, if he is to use cow-dung for agricultural purposes. He was very successful in this, but the immediate problem was the provision of forest

officers. It was necessary to provide additional forest staff not only for the Indian States but for the Provinces, who had accepted the policy of doubling the area of their forests.

It takes two years to train a gazetted forest officer or a forest ranger and, while we could get students, the difficulty was to obtain instructional staff. It was difficult to convince Government that the training of forest officers could not be confined to the lecture room, but was primarily a matter of teaching practical forestry in the forest. For this one needs a special type of instructor. The classes ran to about 40 students in the ranger college and 30 at the officers' college, and you must have one instructor and one assistant instructor for each class. Doubling the number of classes meant providing two more instructors for each additional class.

The Provinces were short-handed and the greatest difficulty was experienced in getting instructional staff. A certain number of officers were prepared to come to Dehra Dun, but some were not of the type required and it would have been useless to accept anyone not specially interested in teaching forestry. This was the fundamental problem. Some officers, who came to the colleges, found Dehra Dun too expensive and had difficulty in obtaining houses; but I understand that things have now improved. I saw the present Director of Education recently on leave, and he told me that there were four ranger classes and two officer classes in residence and that a further expansion to six ranger and four or more officer classes was being seriously contemplated. In all, therefore, forest education would deal with some 240 ranger and 120 or more officer students; and comparing the figures with those at public schools in this country, it will be seen that forest education in India is not a small matter.

It was fortunate that the Government of India agreed to create a new post of Director of Education. This was a wise policy, because one person could not deal with both forest research and forest education. I do not think I have anything further to say, except that I hope it is realised that it is on the training of forest staff that the carrying out of forest policy must largely rest. The budget for research and education was of the order of 14 lakhs of rupees, and the last thing I did before leaving India was to prepare a revised estimate of what would be required. I said that some 120 lakhs of capital outlay might be required and that the recurring expenditure might have to be doubled or trebled. At times one felt that Government was too inclined to live from hand to mouth, lending a rupee to-day for a return of two rupees tomorrow. The training of forest staff is an investment for the benefit of the whole country, and unless this is realised the forest policy outlined by Sir Herbert is not likely to materialise.

Mr. GIBSON: We have heard how hard put to India is and will be in meeting her domestic requirements for timber and fuel, but our lecturer very rightly perhaps forgot that the technological side of the use of timber is only now approaching its majority. We have, for instance, the newly created industry in India of making pulp from bamboo. Only a few weeks ago I received a prospectus from India for the manufacture of rayon from bamboo pulp. Cellulose acetate can be made from bamboo. With the increase in the industrial development of India, where are the timber resources to come from to meet the demand? It is an important point, because India from the wood pulp and bamboo pulp point of view must depend on her own resources for her increased industrial requirements. Many years ago I made a careful survey of the coniferous supply of the Indian forests and I came to the conclusions, on personal knowledge and after studying all available documents, that at the most India could count on 23 million cubic feet of coniferous timber a year to meet her increase in requirements (that is quite apart from structural timber, railway sleepers and so on) and therefore that any big scheme for developing industries based on timber would be difficult. I may have been right or wrong, but on the basis of my conclusions I turned down wood pulping schemes in the north and also timber for matchwood supply. The annual revenue in India based on pulping of *Pinus longifolia* is determined by the quantity of forest available. At one time we thought turpentine would have a big export market. We have now realised that that is not possible. India is supplying about 85 per cent. of turpentine from indigenous

supplies, but even to-day imports are coming in from America and to some extent from France.

What is the solution? Our lecturer has alluded to the suggestion of making every acre of land capable of growing a forest crop grow the maximum quantity of timber and fuel. Again, India requires modern chemicals for the development of her modern industries, the principal of which is the production of methyl alcohol, which is the basis of the manufacture of formaldehyde. The demand for charcoal is enormous. Acetic acid is required if India is going to use her cellulose products for the manufacture of cellulose acetate, which is used more and more to-day in industry. That means an outlet for all small wood timber all over India. I would strongly endorse what our lecturer said, that every acre of land capable of producing timber should be dedicated to the production of timber, and I also endorse what Mr. Simmond said from the point of view of stimulating production. We must have the training for these officers.

Mr. H. K. SRIVASTAVA: Could the lecturer say something of the forest resources of the Andaman Islands? I should like to know whether the Government of India is thinking of exploiting them. We often hear of very good timber there.

Dr. D. CHATTERJEE: I am grateful for the lecturer's suggestion of a liberal utilisation of cow dung as a manure for the land in India. It is unfortunate that a large quantity of cow dung is burnt as a fuel by the cultivators. This, I feel, is not due to total ignorance but rather due to necessity. In our country the road system is not well developed, and delivery of wood fuel to distant villages becomes very difficult and often expensive. This difficulty is further intensified during the monsoon months, when hundreds of villages in Eastern India are cut off for weeks from the supply of all commodities. Such conditions induce the cultivator to utilise the dried cow dung cakes, specially stored for such occasions, as fuel.

Sir HERBERT HOWARD: I do not think there was anything in Mr. Simond's remarks which calls for any particular comment from me except to endorse them. I know how important both education and research are and I know that it is not possible to attempt to run forests or a Forest Department without having properly trained officers who understand their profession. Certainly all forest officers are agreed on that.

Mr. Gibson brought up a point which is, or ought to be, the basic principle in the utilisation of forests, and that is that you should not start large timber industries unless you are sure you have the forest supplies to keep them going. I do not think he actually gave an example of an industry which had been started in that way and had failed, but no one is better qualified than he to tell you of such undertakings which did fail, because to have kept them going and to make them pay needed more raw material than the forest which supplied them was capable of producing. While everyone will agree with what he said, in order that there may be no misunderstanding, may I remind you that the policy of the Government of India which I outlined is not that it should start encouraging industries—that was not said anywhere. I think forest officers have learned their lesson sufficiently not to try to encourage industries until the raw materials exist. It is true to say that there is not sufficient material in the Himalayas (at least if you exclude that which would go to the more valuable uses of the type required to supply any very large pulp wood industry). There is enough material which now goes to waste to keep one or two mills going, but that is about all. It cannot begin to supply the real needs of India if India becomes a largely industrialised country. The policy all through —at least the basic part of it—is to supply the village demands. As I said, the ordinary demand at present (not the future demand) is fairly well supplied. The big problem is the village demand and therefore the stress all the time has been laid on the fact that the forests necessary to supply that demand are not forests for which you will have to wait 120 years. They are short rotation forests which should give you a return four or five years after they are put down, though there is nothing in this policy to prevent the better lands in an area being used for long rotation forests. The emphasis is on the short rotation forests because that is the really crying problem in India at the moment. Nor is the argument based on whether forests help agriculture or not. In India forests are

necessary not to help but to save agriculture. Where longer rotation forests are grown then, when the supply is sufficient to supply a given demand, and then only, should a wood industry be started in that particular place. It is folly to encourage an industry before you can supply the raw material.

The Andaman Islands have been exploited for many years. Before the last war there was a very flourishing sawmill at Chatham yielding a reasonable revenue from the Andamans. I think it was about three lakhs. We had plans to double that but the Japanese came and all work naturally stopped. We have now gone back with a complete plan to restart work. The forest officers are back and the forests are again being exploited.

The last speaker in the discussion referred to the question of transporting fuel to the villager if we were going to give effect to the policy of providing fuel to prevent the burning of cow dung. The real necessity is better distribution of these forests so that long transport is unnecessary. The whole idea is that forests are so distributed that all villages are within easy distance of some forest to provide their fuel. That is not easy, but it is easier than you might think, because if you take the ordinary day's journey a village cart can make, then within that radius you will find a very considerable area which can, in fact, produce fuel. In the United Provinces there are some 2,000 square miles of small mango groves. Sometimes a grove is only two or three acres. They are badly managed, but if they were all properly managed they would come within measurable distance of solving the problem in those areas. Two or three acres is not a lot, but if you take a radius of ten miles, which is within the range of a village cart, and add up all those three and four acre mango groves, it mounts up to a very considerable area. Although you cannot produce a plan of management for two or three acres you can do so for a number of groups of two or three acres, each being considered as a compartment.

THE CHAIRMAN: It falls upon me to make a few remarks in the form of a short summary of the lecture we have heard and the interesting remarks which have been made upon it. I think one of the greatest values of the lecture this afternoon is that it practically gives us a picture of the forests of India and of the work that has been done on the forests in India almost up to the present time. That is a very valuable picture to have, both now and for the future, because so far as the work of the Indian Forest Service is concerned it has practically come to the parting of the ways. The greater part of that work has been done by men trained in this country and we have had a very good picture of the results, although not as strong a picture, owing to an understandable diffidence on the part of the lecturer, as I should like to portray. I do not think that sufficient credit has been given to the officers of the Department who, through the years, have built up this magnificent forest estate. Certainly we can say that there is not, at the present moment, any finer area of State forests than in India nor, for their large size, one that for a long period of years has been better managed.

One very significant point may be put forward to confirm my statement, and that is that during the first Great War an enormous amount of material required for the Forces was sent to the Middle East, which was quite an unknown type of work for India to undertake. In the memorandum on future forest policy on which this lecture is to some extent based, written by Sir Herbert Howard and published the year before last, one of the most striking things from the educational man's point of view is the fact that it showed that India is probably the only country in the world at the present moment with great forest areas under well-drawn working plans. The prescriptions of these plans lay down what shall be done over a period of years, sanctioned by the Government, and that policy cannot therefore be departed from by the forest officers working in the areas. The Inspector-General has said "We know what the emergency war fellings have been, but by retrenching and cutting short our fellings for the next five or ten years we can get back to normal production". I am sure there are no other forests in the world of which that can be said. Certainly not in the United States of America or Canada, and I am sure you cannot say it about Russia and most of the rest of the world after the disastrous losses by lumbering, bomb and battle. In the Colonial Forest Service

those with big areas of forest were called upon to cut. East and West Africa were called upon to cut. That is professionally a proud position and a very fine monument to the Indian Service of the past. Now there is to be a service of the future and it has a great responsibility. I agree that trained men are absolutely essential, but when you think of the size of India, I, personally, should not be aghast in finding my forest school or college running up to 150 or 160 students. During my first leave from India I went to Russia, and in St. Petersburg I found out that there was a Russian Imperial Forest College. I called there and was shown round and they had 240 students for the gazetted grades. It gave me a shock when I thought of our small numbers training for India. But when you think of the size of the country it was obvious. Looking at India, plus the Indian States, it is obvious that we shall have to build up Dehra Dun enormously to train the men required to carry out this big future forest policy.

Mr. C. E. SIMMONS: I was only pointing out the extreme difficulty of getting forest officers to deal with the problem. You cannot teach forestry merely by lectures and my difficulty, apart from buildings, was to get Provinces and States to let me have suitable forest officers, who were capable of teaching the students. At times we have had to accept as instructors, officers whom we would have preferred not to have had. Naturally after the war, when the Provinces were short-handed and wished to get on with their own work, they were not keen on letting us have the pick of their officers. We knew of plenty we should have liked to have had. The difficulty was to convince Provinces that it was worth while to train for the future as an investment and not to take too short-sighted a view. I was not aghast at the size of the problem and was prepared to train any number of students, but not without the instructional staff.

THE CHAIRMAN: The people at Dehra Dun are not the only people in that position. Sir Herbert Howard can tell you that in this country we also are looking about to find staff. That staff must be of the right type otherwise it is useless.

One remark about training. I myself insist that until the students have been in the lecture room they cannot go out into the forests. The two types of training must go hand in hand. I have heard so much about all the training being outside, but the students must be given their theory first. With regard to the maps shown by the lecturer they are, of course, quite new to anything we have ever had. The forest areas look small, it is true, but those maps showed all the real forests and, taking all the scrub, they showed what a very afforested country India is, provided that the destruction can be arrested. I think that is one of the vital points.

Just one last remark about this question of forests and industry. You cannot set up big industries unless you can make sure that you have the material in the neighbouring forests to supply the particular factory set up. But India may become a big industrial nation; and if so, she will have to have forests, because other people are also becoming big industrial countries. If you look into the future the problem for all the countries of the world now is that they have got to settle what area of forest they want, not only from the point of view of protection and climate but from the point of view of industry. I do not believe that the big countries are going to be able to import forest material for very long. I used to say, between the two wars, that this country could get all the timber and pit props she wanted from Russia; but look at Russia now. I went up through the North Russian forests to the Urals and gave a lecture at a time soon after the first War. Up in the Urals I was told there were minerals, and gold and coal, all covered with the unending forests. When I mentioned this in my report, Foreign Office officials took it for a traveller's tale. But this is where Stalingrad developed. Russia has the biggest European areas of coniferous forests, but how much are we going to get from there, now that she is becoming a big industrialised country? I think that the young student taking up forestry must remember that India will have to make up her mind what area of forest she wants in the future if she is to become industrialised, because certain industries are going to depend on forest products. And imports will tend to increase in a mechanical and greatly industrialised future.

On behalf of the audience, I will express our cordial thanks to our lecturer for the

lucid manner in which he has drawn his picture of the present position of the forests of India. Sir Herbert, we thank you.

Sir DAVID CHADWICK, K.C.M.G.: I am sure that you would like to pass a very hearty vote of thanks to our Chairman for coming and presiding over this extremely interesting lecture. He certainly deserves it. He risked travelling down from Edinburgh last night* in order to be here this afternoon. Amongst foresters his name is one which is held in veneration and respect. He is known to many succeeding generations and his enthusiasm for his subject increases with his years. We all wish him a very, very long life, and if this is granted him, no limits can be set to the heights to which that enthusiasm will rise —and forestry is a long-term subject! We thank him very much for coming here to-day.

The vote of thanks was carried with acclamation, and the meeting then terminated.

DR. MANN JUVENILE LECTURES

(I) THE CHILDREN'S HOUR OF THE B.B.C.

By DEREK MCCULLOCH, O.B.E.
(*Director of The Children's Hour*)

Delivered Wednesday, January 1st, 1947

The primary object of the B.B.C. Children's Hour, radiated every day, including Sundays, at 5 o'clock, is to entertain and interest the younger listener. While the audience is very considerably the same as that in Schools Broadcasting, the programmes are entirely different, the Schools programmes being educational.

The chief aim of the Children's Hour is to provide a daily programme of entertainment for the young listener. Much has happened in this sphere of broadcasting since its first rather haphazard excursions into the ether in the year 1924 round about tea-time. It has grown into one of the few regular features which have never lost their place in the programmes. Its daily time allocation has varied, fluctuating from fifteen minutes to thirty, with an increase to forty-five and then the full hour. In war-time a cut came to forty minutes each day, but at present there is a daily output of fifty-five minutes, which would be a full hour were it not for the Weather Forecast.

"What do we do?" Gone are the days of the funny uncle and the whimsy aunt who bantered and chaffed together at the microphone, much to their own amusement but, I dare venture, to the fury of the average listener. I must not be too harsh, however, because these people also gave us stories, plays, songs and features. But we have indeed grown up, and our programmes with us.

To-day we have one of the biggest and most loyal audiences in broadcasting. Since the early beginnings referred to we have held our regular place in broadcasting, and it is true to say that the B.B.C. gives more attention to this branch of its many services than does any other similar broadcasting institution in the world. I have reason for saying so as I have just returned from a tour of eight of the major capitals of Europe, and I saw a good deal of radio work. I am afraid not much consideration is given to the younger generation.

There is something which lies behind the mere entertainment radiated between five and six o'clock. That something is a desire to project the idea of "good listening"

*The meeting was held during the period of snow and cold weather which dislocated transport and occasioned the fuel crisis.—ED.

to the younger generation. This may sound a bit smug, perhaps, but it is not so intended. Why throw away an hour's wireless entertainment for children—children of all spheres, shapes, sizes and temperaments—when it is so possible to give them in it some sort of sugar-coated pill—without coupons!

To-day the B.B.C. Children's Hour is a miniature of broadcasting as a whole. We produce all kinds of programme for every kind of child. Fundamentally, I believe that in the main the listening tastes of children do not much differ—except when jazz and swing are all the rage at home. Our programmes cannot reach children who have to run errands, mind the baby, and play in the street. The housing problem, including the removal of slum areas, must be completed, giving a better post-war world before back-street youngsters can be receptive to Children's Hour programmes.

Then again, take the question of tastes. We all went through the same phases when we were young—dolls, trains, conkers, marbles, tops, nature study, hobbies, and so on. Children to-day do the same things, even though electric light switches and wireless set control knobs are taken for granted now.

Throughout the year we broadcast plays of all kinds, historical, adventure, fairy, thriller, and, on Sundays, "Stories from the Bible". We have stories and dialogues where famous characters of history and literature come to life. We have music, symphony concerts for children, songs and talks on great composers. Both in music and poetry there is a minority audience. But we keep pegging away, hoping to help the young listener to learn to like both these arts. Competitions, variety, quiz programmes, outside broadcasts of all kinds, sporting items, young artists, and religion—all find their place in our programmes.

Christianity is needed in the world to-day, so Children's Hour Prayers are regularly broadcast. There are also Children's Services, hymn singing and carols, and religious talks. Religion is difficult to project, but it is carefully handled and no child has ever objected to some religious instruction in programmes. That is interesting, because young listeners quickly clamp down upon items they don't like and write to us about them.

As to the quality of programmes. Our motto and aim is "only the best of everything". Thus, only professional artists of high standing act in plays and we cannot encourage amateurs. We only employ young artists when we consider they have a career ahead, and therefore should be encouraged.

Exactly the same principle of quality extends to speakers: Thus, we name Megan Lloyd George, Stephen King-Hall, Ronald Storrs, Vernon Bartlett, R. T. Gould, Peter Scott, Helen Henschel, H. V. Morton, L. Hugh Newman, Zoo Man (David Seth-Smith), Geoffrey Vevers, Eric Gillet, and others as being representative of the requisite standard and status.

In Children's Hour we are trying to entertain the young listener who is the citizen of the future, and potential wireless-licence purchaser in years to come. It is our duty to try and serve them loyally and well, and in that endeavour I must gratefully acknowledge official backing so readily forthcoming.

In conclusion I would like to mention some members of London Children's Hour staff: May (Elizabeth) Jenkin, a loyal Assistant Director over many years; "David" Davis, accompanist and assistant; Geoffrey Dearmer, editor and general adviser in

religious programmes; Josephine Plummer, producer-assistant, and our newest recruit. Without their efficient help, together with that of Children's Hour Organisers in all our Regional Centres, my task would, indeed, be a formidable one. It *is* difficult enough whichever way you look at it, for children are highly discriminating, and in no circumstances should they be played down to, or their intelligence underestimated in the smallest degree. At all events, we try to steer clear of those pitfalls and I believe we are reaping a reward.

It is a real pleasure and a great privilege for me to know that, after a matter of over twenty-one years as a radio "Uncle", I am now Uncle Mac to millions.

(*Note.—This lecture consisted largely of recordings and demonstrations from radio programmes, etc., and the above is Mr. McCulloch's summary of it, which omits references to the numerous illustrations of this nature.*—ED.)

(II) THE STORY OF GLASS

By J. H. PARTRIDGE, B.SC., PH.D.

Research Laboratories, General Electric Company, Ltd.

Delivered Wednesday, January 8th, 1947

In the reign of Gulkishar, the first king of the Dynasty of the Sea-Land, an Assyrian chemist recorded on clay tablets a recipe for making glass. This king reigned nearly 3,600 years ago, so that glass is one of the oldest of manufactured materials, for specimens nearly 6,000 years old have been found in Egypt. Specimens made 3,000 years ago are fairly common* and are coloured and quite different in appearance from glass as commonly known to-day. Hundreds of years were to pass before the secret of making colourless glass was discovered—colourless glass is that most commonly seen to-day and it is used for windows, bottles, tumblers and many other articles you see every day.

Now why was the making of glass practised before that of the common metals of to-day? In order to answer this question, we must try to imagine the conditions under which people lived in those far off days. The first drinking vessels were made of the skins or of the horns of animals—indeed, skins of animals are still used even to-day by the more primitive people. It is not possible to boil water and so have a hot drink or to cook food in a skin however, and at a later period we find crude pottery being used. Pottery is moulded from clay just as plasticine is shaped—indeed, plasticine is a mixture of clay and vaseline—and the vessel is dried and fired to a high temperature. In olden days a wooden fire was built with the clay article in the middle. The fire was lit and kept burning for some hours. When it had gone out and the ashes were cold, the vessel was found to be quite hard and ready for use. The vessels exhibited were made from clay dug out of the ground at Wembley*. All pebbles and small stones were washed from the clay, which was then moulded to shape. When dry, the vessels were heated slowly to a good red heat. They do not look very elegant, but they would have been very useful had you been living some

*Specimens of ancient glass and of vessels made from local clay were exhibited.

4,000 years ago. The only metals which could have been used instead of this pottery, were gold and silver, because they are found in the earth as metals, they are easily melted over an ordinary fire and they are malleable, *i.e.*, they can be hammered into a useful shape such as a drinking vessel. However, such vessels of gold, silver or even bronze took longer and were more difficult to make than those made of pottery in the manner just described.

Now glass can be made by heating a mixture of sand, soda and lime, all easily obtainable materials, in a fireclay crucible to a fairly moderate heat and it can then be moulded to shape rather like clay or plasticine, except that it has to be moulded while it is still red hot. The moulded vessel is cooled slowly, and is then ready for use. Glass thus possesses advantages over the metals, such as gold and silver, because it can be made fairly easily; further it can be moulded quickly and easily to the shape of a cup or of a jug. How quickly and simply, you will see in a few minutes from the film. It is this property of being moulded so readily to the finished shape which makes glass such a valuable material, and no other material behaves like it. For example, if one end of a rod of metal is heated it suddenly melts and falls to the floor. But if a rod of glass is heated it slowly bends and flows rather like thick treacle. It is while in this plastic state, or viscous state as it is called, that glass may be moulded very much like clay or plasticine.

Glass in this plastic state may be rolled into a sheet just as Mother rolls pastry. The molten glass is contained in a large fireclay crucible, which is lifted out of the furnace, poured on to an iron table and rolled into a sheet with a large iron rolling pin. The sheet of glass so obtained, is slowly cooled and then cut into smaller sheets which are used for the roofs of large buildings, such as railway stations; or the sheets may have their surfaces ground and polished for use in shop windows. A photograph, taken during the lecture, reproduced in Fig. 1, shows molten glass being poured on to an iron plate preparatory to being rolled into a sheet. When it is in this plastic state, glass may be drawn into very fine threads—finer than the hair on your head—and these threads of glass are woven into glass cloth which can be used for many purposes—for example, fire-resisting curtains, insulation for electric cables and for steam pipes, and these threads have even been made into a glass dress. Two rods of glass may be melted in a flame and welded together, a process which is not so easy in the case of metal. Glass thus behaves quite differently from metal. Molten metal is a very fluid or thin liquid; it is nearly as mobile as water. When cooled it changes suddenly to a solid because the atoms can move easily and quickly and so arrange themselves into a pattern. In contrast, molten glass is a very viscous or thick liquid; it is so viscous that the atoms cannot move quickly and arrange themselves into a regular pattern. On cooling, glass does not therefore set suddenly into a solid but it gradually becomes thicker and thicker or more and more viscous, until it gradually becomes solid. On heating glass becomes more and more fluid; on cooling it gradually sets to a solid.

Because of its viscous nature it is possible to pick up or "gather" a quantity of molten glass on an iron rod, in very much the same way as treacle is wrapped round a spoon, and then let it fall into an iron mould. An iron plunger then descends and forces the molten glass to fill the space between the plunger and mould. The iron cools the surface of the glass, which then becomes "solid" or at any

rate sufficiently rigid for the glass to be taken out of the mould in the form of a finished article, such as a glass dish. This process is known as pressing, because the molten glass is pressed into its final shape by the downward movement of the plunger*.

HISTORICAL SURVEY

Now the processes which have been demonstrated, namely, that of pouring a large quantity of molten glass on to an iron table and rolling it into a sheet, or of pressing glass articles, are fairly modern and are in use to-day. Such methods were not used



FIG. 1.—*Dr. Patridge demonstrating the rolling of glass at the lecture*

by the ancients, because they were not able to melt glass in such large quantities. The earliest vessels were made by covering a sand core bit by bit with viscous glass, just as one might cover an article with plasticine or perhaps sealing wax. This was a slow and laborious process. A better and more rapid method of working glass was invented in Roman times between the years 50 and 20 B.C.—say 2,000 years ago—which was responsible for a rapid growth of the industry, because it enabled better articles to be made more quickly, and so at lower cost. This was the process of glass blowing. Glass is a viscous liquid and so it can be gathered on the end of a hollow iron tube or blowpipe. This mass of hot glass may then be blown into a hollow ball by blowing

*A film was prepared to show the pressing of molten glass into finished articles.

down the blowpipe, as in Fig. 3 (*a*) and (*b*). A tubular shape is obtained by swinging the blowpipe, thus causing the ball to elongate. Other shapes such as tumblers, electric lamp bulbs, and so on, are obtained by putting the hot tubular piece of glass in a mould and blowing down the iron until the hot glass is blown to the shape of the mould.

The Romans became quite skilled glass-makers, but we know little of what happened after the fall of the Roman Empire until Venice became famous for making glass about the beginning of the twelfth century. Little glass was made in this country until the Middle Ages, when small quantities were made in Surrey and Sussex. Places near London were chosen partly because the glass could be sold easily in London; but more important, sand and lime were available and the country was well wooded. Wood was needed to heat the furnaces in those days, for coal was not available. Further, the ashes of burnt wood and of ferns were used to provide the alkali for glass making—in this case a crude form of potash instead of soda. These places in Surrey and Sussex made window glass in 1352 for St. Stephen's, Westminster.

Owing to religious persecution in Europe, foreigners came to England to start making glass here, and they taught Englishmen how to do it. There must have been many glass works in this country by the year 1565, because a map of the country showing their sites was painted in that year and is now in a museum in Florence. A glassworks of these times is shown in Fig. 2. The process of "gathering" and blowing glass can be seen in the picture. The wooden mouth-pieces to the irons, to economise in the use of iron, should be noted. The furnaces were heated by wood; trees and men carrying wood can be seen in the background. These glassmakers were gradually burning all the wood and so destroying the forests. The procedure was to build a small furnace in the middle of a wood and to cut down the trees for fuel. When all the trees for a few miles around had been used, it was easier to move to a new site and build another furnace than to transport wood, because the roads were so bad. In this manner by the beginning of the seventeenth century these glassmakers had spread from Surrey and Sussex as far west as Bristol, and as far north as the Midlands, burning the wood from the forests and leaving their old furnaces and piles of rubbish behind them. There were many complaints in Parliament, and in 1615 the use of wood for fuel was forbidden, because a patent had been granted in 1611 for burning coal in glass melting furnaces. The clay crucibles used in the Middle Ages were small, in fact not much bigger than an ordinary household pail. Crucibles and furnaces became larger, as you have seen from the slides, and, of course, the use of coal instead of wood enabled the furnace-men to make the furnaces hotter. The use of hotter furnaces and of purer chemicals which became available with the growth of the knowledge of chemistry at the end of the eighteenth century resulted in an improvement in the quality of the glass, much of which was fashioned by being blown.

All hollow vessels such as bottles and tumblers were mouth blown until the beginning of the present century. Even window glass was made in this manner (Fig. 3). The glass blower blew a large globe of glass as shown in (*a*) and (*b*). While it was still hot a second workman stuck his blowing iron by means of molten glass on to the bulbous end of the globe, which was then severed from the first iron as

shown in (*c*). The second workman thus had what appeared to be a large glass bowl on the end of his iron. He re-heated this in the furnace until the glass was very soft, and spun the iron rather like wringing a mop, thus causing the bowl to open out into a flat sheet or disc, seen flat and edge on in (*d*). This was then cut into small squares or rectangular shaped panes for windows, as marked by the dotted lines. The centre piece was spoilt by the blob of glass by which it was attached to the iron, and so was sold at a lower price and was to be found in the houses of the poorer



FIG. 2.—*A glassworks of the sixteenth century (from Georg Agricola's "De Re Metallica," published in* 1556)

people. More recently such pieces of glass have to be made specially, and at a higher price than ordinary window glass, for the windows of imitation Tudor houses.

The cutting of window panes from a circular sheet of glass was very wasteful and a different method was evolved known as the split cylinder method, in which the glass blower blew a large cylinder of glass. The ends were cut off to give a tube which was then slit with a diamond cutter into halves as shown in the figure. These semi-cylinders were placed on a block of plaster of paris and heated in a furnace until the

glass became so soft that it could be flattened into a sheet using a block of wood as the ironing tool. The man starts with a short cylinder of glass, but by re-heating, blowing and swinging he finally produces a glass cylinder about 2 ft. in diameter and between 5 and 7 ft. in depth.

Apart from improvements resulting from hotter furnaces, and the use of larger crucibles and purer chemicals, there was little change in the process of glass making until the introduction of machinery in quite recent times. This called for glass in much larger quantities than can be melted in fireclay crucibles. Glass to be worked by men rather than machines and also special glass, is still melted in crucibles but for machines glass is melted in tank furnaces. These are built with large fireclay blocks. Such a furnace might be compared with a swimming bath. The molten glass takes the place of the water while the space between the surface of the molten glass and the roof of the furnace is filled with flame to keep the furnace hot and the glass molten. The pool of molten glass in these furnaces may be as much as 60 ft. or more in length, up to 25 ft. in width and between 3–4 ft. in length.

The making of window glass was described to illustrate the viscous nature of glass. It must not be thought that window glass is made by these processes to-day, although the split cylinder process was in use until a few years ago. Window glass is now made by a continuous process in which a wide sheet of glass is drawn vertically upwards by many pairs of rollers from a large pool of molten glass contained in a tank furnace such as was described. But even this apparently simple process, and indeed, all processes used for shaping molten glass, make use of its peculiar viscous and plastic properties which I have tried to describe.

Composition

There are many kinds of glass, but most of it is made from a mixture of sand, soda and lime. Glass for bottles, windows, food containers, electric lamp and valve bulbs is made from a mixture containing about

70 parts of sand,
25 parts of sodium carbonate, and
15 parts of calcium carbonate or lime,

although some of the lime is sometimes replaced by magnesia owing to the use of dolomitic limestone, that is, limestone containing magnesium carbonate. A mixture of sand and soda will make a glass, but it is soluble in water, and as such is known as water glass. Lime is added to make the glass durable. These raw materials are mixed together and shovelled into big crucibles made of fireclay contained in a furnace, or into the tank furnaces just described. The crucibles vary in size, but the largest hold nearly two tons of molten glass and are about 5 ft. in diameter and 30 inches in depth. Tank furnaces may hold any quantity between a few and 1,000 tons of molten glass. I want you to note that the materials themselves are not melted. Chemical reactions take place between the sand, soda and lime and glass is formed as a result. Carbon dioxide from the decomposition of the soda and the lime, and also the air entrapped between the grains of the raw materials, form tiny bubbles in the viscous glass and it may take between 8 and 30 hours for the reactions to be completed and for the gas bubbles to rise to the surface so as to leave clear glass free from bubbles and other unsightly blemishes. The bubbles rise slowly to the surface because molten glass is so viscous. Under favourable conditions, glass made

from the mixture of sand, soda and lime I have just indicated, will be colourless, provided that white sand containing less than 0·05 per cent. of iron oxide is used. Glass made from sand containing more than this very small proportion of iron oxide is coloured green. Thus, the addition of a very small amount of iron oxide produces a green colour, and this is one of the principal methods of producing coloured glass. Thus, the addition of

Iron oxide Copper oxide or Chromium oxide	produces	Green glass.
Cobalt oxide		Blue glass.
Manganese dioxide		Purple glass.
Uranium oxide		Yellow glass.

Another method of colouring glass is to have very many tiny particles of material scattered through it. Thus tiny particles of colourless material may result in a white or opal glass, tiny particles of gold or of copper produce a red glass, cadmium sulphide a yellow glass, while particles of cadmium selenide and cadmium sulphide produce colours ranging from orange to dark red, depending on the proportions of the two constituents. These glasses are nearly colourless and have to be heated to allow the particles to be precipitated.

Physical Properties

The most characteristic feature of glass is that it breaks easily. If glass is dropped, it breaks and we say that it is brittle—now what do we mean by being brittle? We have seen that glass can be deformed quite readily when it is very hot but once it is cold it cannot be deformed. If a glass rod is bent it suddenly breaks and we say that glass is brittle. Some metals on the contrary can be deformed quite readily—for example, these rods of iron copper, lead and tin are bent easily, and we say that these metals are ductile. Now if a rod of glass or of metal is bent slightly and then released, it springs back to its original position, *i.e.*, it has not been bent permanently. But if they are bent further the metals bend and remain bent, whereas glass breaks. Metal is ductile and glass is brittle. Now let us see if we can state more precisely what this means. If a weight is hung on the end of a rod of metal, it causes the metal to stretch very slightly and the amount it stretches can be measured. Thus, suppose a weight of say 100 lb. is hung on the end of this steel rod and we find that it stretches by an amount of 1/100th of an inch. It is observed that it stretches 2/100ths of an inch when a 200 lb. weight is hung on the end of the bar and 3/100ths of an inch for a 300 lb. weight, and so on. However, after a number of these 100 lb. weights have been hung on the end of the bar, we find that the addition of a further weight causes a very much larger stretch or elongation and this continues until the metal breaks. Here is a specimen of steel which has been stretched in this manner and the elongation is quite noticeable. Now glass behaves like metal until it reaches the stage at which the addition of a further weight causes a noticeable increase in the elongation of the metal. Instead of stretching as the metal does, the glass suddenly breaks. In other words, glass will not stretch appreciably like metal, it prefers to break instead. Now let us see how this explains why glass breaks so easily whereas metal does not. Consider the bending of rods of metal and glass again.

If the metal could be bent into a complete circle, it is seen at once from Fig. 4 (*a*) that the outer edge of the rod must be longer than the inner edge and so it must stretch to do this. It follows that if a single straight bar is bent into an arc, the outer layers are stretched and the inner ones compressed (Fig. 4 (*b*)). We have already seen that a ductile metal will stretch quite appreciably and so we are able to bend a metal rod. Glass will not stretch, and so it is not possible to bend a glass rod to

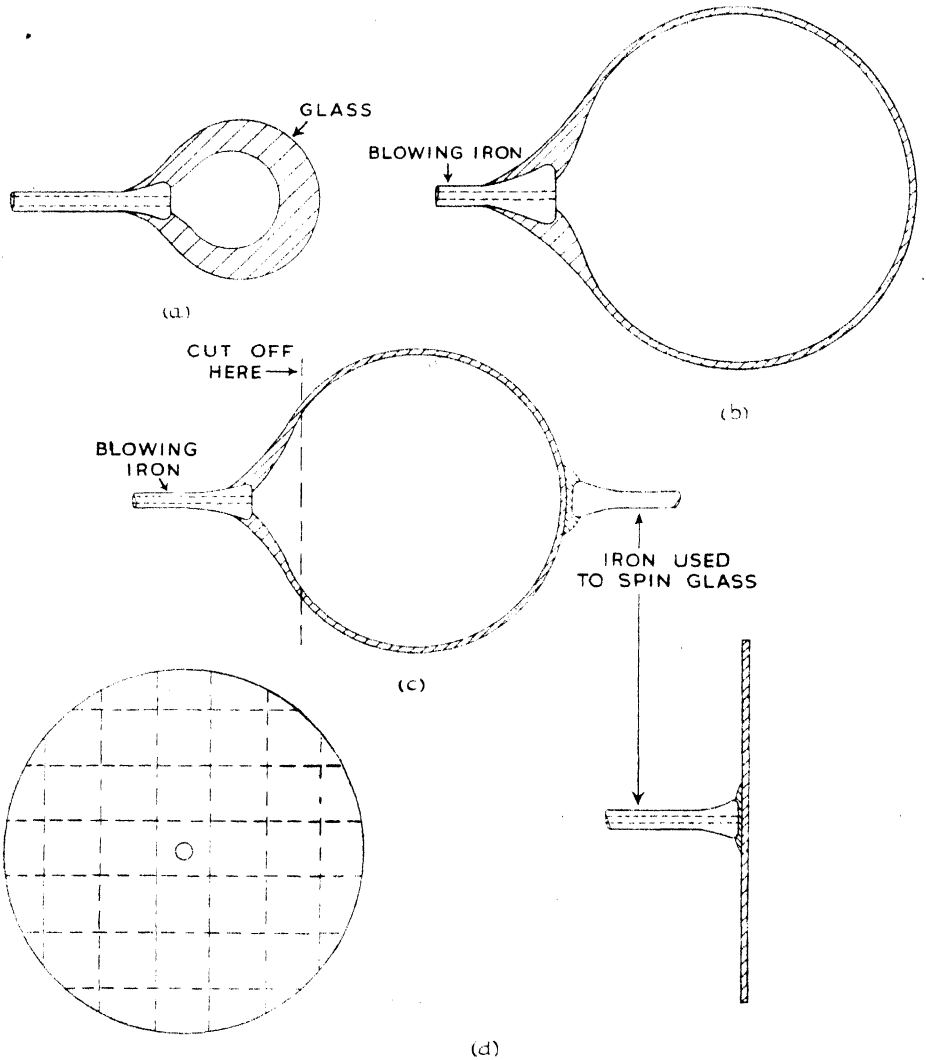


FIG. 3.—*Window glass making by the "Crown" process*

the same extent as a metal one. This is precisely what happens when a tumbler is dropped on the floor. The edge receives a blow when it hits the floor which tends to force it to assume an elliptical shape, Fig. 4 (*c*). The outer layers of glass have to stretch, at A, A, and if the blow is a light one, they will stretch slightly and the

tumbler does not break; if the blow is heavier, however, the glass will not stretch sufficiently and the tumbler breaks, whereas a metal vessel would become permanently bent instead of breaking.

There is another important difference between glass and metal. A very much larger weight must be hung on a rod of metal in order to break it than upon a rod of glass of the same size. Very approximately a weight of 6 tons would be needed to break a rod of glass 1 in. in diameter whereas about 20 tons would be needed to break a similar rod of steel (depending on the kind of steel, of course), and so we say that metal is stronger than glass. This is only true however when the materials are being stretched. We find that glass is quite strong when it is being compressed—thus,

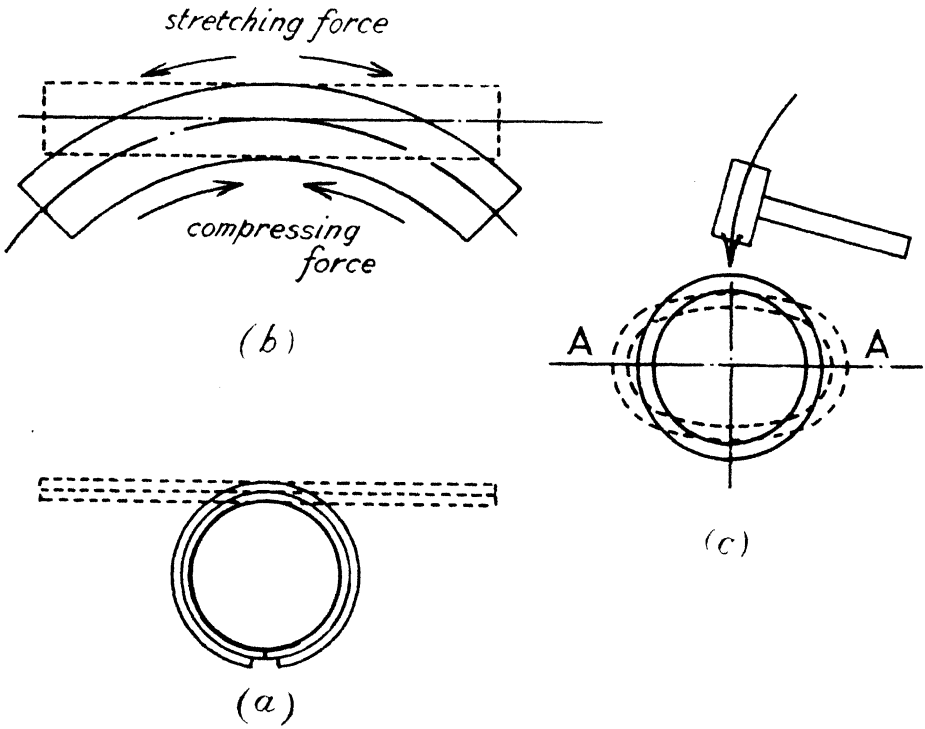


FIG. 4.—*The changes of shape and the forces involved in the fracture of glass*

an inch cube of glass would need a load of about 60 tons to cause it to break when it is being compressed, so that glass is very much stronger when it is being compressed than when it is being stretched. Turning for a moment to the bent rod shown in Fig. 4, we see that the outer layers are being stretched while the inner layers are being compressed, and it is clear that the rod breaks because of the stretching force and not because of the compressing force. How can we apply this knowledge to make glass less liable to break? Now, if we can arrange for a compressing force to be present in the outer layers of the glass before we bend it, this compressing force counteracts the stretching force, so that if we wish to break this special kind of glass, we have to apply a much bigger stretching force, part of which is used to counteract the compressing force leaving the remainder to stretch the glass to its breaking point.

The glass is thus stronger than ordinary glass because it needs a bigger stretching force. The difference between them is seen when they are broken by dropping a heavy iron ball on them. The force of the falling ball causes the glass to bend, and, if the blow is heavy enough, the glass will be bent so much that it breaks. A piece of ordinary plate glass 5 mm. in thickness needs the force of a ball $2\frac{1}{4}$ in. in diameter and 1·68 kg. in weight falling from $1\frac{1}{2}$ ft. to 2 ft. to break it, but a piece of glass in which the outer layers have been compressed slightly needs a blow corresponding to a fall of as much as 8 ft. or more before the glass breaks. This glass is stronger because the compression forces in the outer layers have to be overcome before sufficient stretching force can be exerted to cause fracture and so the ball has to be dropped from a greater height. This special kind of glass is known as "toughened glass", and it is tough in the sense that it is stronger than ordinary glass. It is used for motor-car screens, first, because it is much stronger than ordinary glass, and secondly, because it breaks into tiny fragments, which are comparatively harmless, instead of large pieces which might cut people very seriously. The toughening of glass is carried out by heating it to a high temperature and then cooling it rapidly. This results in a compressing force being present in the surface layers which makes the glass stronger, as we have already seen. You may have noted that from certain positions a motor-car screen appears to be covered with circular patches. These correspond to the air jets used for this cooling. When you see this, you know at once that the glass has been toughened. This process of toughening is not new. Pieces of glass made by allowing molten glass to fall as droplets into water are known as "Rupert's Drops" because they were introduced into England by Prince Rupert of Bavaria, grandson of James I of England, about the middle of the seventeenth century. He showed them to the King and Pepys saw them, for he recorded in his diary on the 13th January 1662 "Mr. Peter did show us the experiment of the chymicall glasses which break all to dust by breaking off a little small end; which is a great mystery to me". Well, we have seen that it is no longer a mystery because the surface layers of these Rupert's drops are under severe compressing forces. They can be hammered heavily on the head and so they are exceptionally strong when tested in this manner. Breaking off the tail upsets the internal stresses within the glass and the sudden release of energy shatters the glass drop. The similarity between the Rupert's drop and the sheet of toughened glass is evident, but more than two hundred years were to pass before this principle of the Rupert's drop was applied to make glass stronger—first in the toughening of gauge glasses for boilers, then to sheet glass for motor-car screens, and now experiments are being made to toughen glass for cooking-vessels.

In the brief space of an hour I have tried to explain the peculiar nature of glass, how it is different from other materials and how advantage is taken of its viscous nature in moulding it to finished articles. We have considered the chemical composition of glass, how it is made and finally its characteristic brittleness. I would like to express my thanks to the directors of the General Electric Co., Ltd. for permission to present this lecture, and to Messrs. Chance Brothers, Ltd., Messrs. Fibreglass, Ltd., Messrs. Pilkington Brothers, Ltd., The Triplex Safety Glass Co., Ltd. and to Professor Harry Moore for the loan of specimens.

I am also indebted to the British Council for the loan of a film.

A LARGE COMPANY CONSIDERED AS A FAMILY

By JOHN J. CALDER

Managing Director, Messrs. Ind Coope & Allsopp, Ltd.

Abstract of Paper arranged to be read on March 5th, 1947

I am giving a brief sketch of a large company where the relations between the management and the employed have been for years of the friendliest description. Such cases are far more numerous than many realise; for they provide no press news, whereas where there is industrial unrest every case is reported with great detail. The company, with its associated companies, employ rather more than 8,000 people, and during the thirty-five years I have been the Chief Managing Director things have gone on peacefully and happily. Most of our people come to us when young and stay with us until they go on pension at sixty-five. The picturesque phrase of the East calling a benefactor one's father and mother is appropriate in our case. The company watches over us all from the man about to go on pension to the young man leaving school and entering industry for the first time. They know the traditions of the company, and have that feeling of confidence and safety which means so much, especially to breadwinners.

The active control of our company is in the hands of a Management Committee, of which, as senior Managing Director, I am Chairman. We have in every important position—whether it is the Head Brewer who produces over 20,000 barrels of beer a week; the Chief Accountant; the General Manager; or the head of the Forwarding Department who sends out some 8,000 tons of beer each week—an experienced and trusted servant. All these head men have a very free hand in carrying out their duties and the control of those under them. We have always made it a rule that not only the chiefs of every department but also their chief subordinates have free access to the managing directors to discuss the best method of dealing with difficulties.

I should, perhaps, make special mention here of our laboratory. This was started in 1862, when, on the recommendation of Baron Bunsen, we employed as our Chief Chemist, Peter Griess, who first discovered nitrogen explosives. He and his three successors, the last of whom is still with us after forty years of service, have been a benefit to our manufacture which cannot be overstated.

I am certain that, while remuneration must be adequate, the uniformly good work we receive arises from the confidence we repose in all our people, who feel it is their department and give of their best. All these people, associated with each other in most cases for very many years, have just that happy, friendly relationship which exists in members of a large family. They take a proprietary pride in the products and the success of the company.

We have recently got back many of our men who have been serving with the Forces. To adjust the financial merits of a boy who left at eighteen and returns a man at twenty-four, is not easy, but we seem to have done it to everyone's satisfaction. This has enabled us to place on pension about fifty old friends who stayed on during the war to help us. Their average age was about sixty-seven, and their average years' service forty-four. Six had over fifty years service. These figures show how loyally the staff stay with and serve the company.

Napoleon said every soldier had a Marshal's baton in his knapsack. This is equally true of our staff and workmen, for there is a constant flow of promotion as older men retire. Our Head Brewer, for example, started with us as a boy of fourteen for a few shillings a week, and has risen on his merits. All our brewers and chemists have to take their regular course at the Brewing School at Birmingham, after they have sufficient brewing experience to enable them to assimilate what they are taught.

The brewing trade justly claims to have been of the chief of those which have used scientific knowledge for many years, and recently agreed to a levy for a permanent research scheme, not only for brewing and malting, but also for better types of barley and hops, in conjunction with the Agricultural Societies. Formerly brewers imported large quantities of six-rowed barleys, chiefly from California. The war forced them to use

only English and Scottish malts. The excellent beer we produce (though that is a relative term, with the low gravities now necessary) could never have been produced were it not for our increased scientific knowledge. It may interest you to know that a barrel of the present low gravity pays £7 10*s*. 0*d*. duty. A similar beer when I entered the brewing trade would have paid 3*s*.

Such interests as our Canteen and Sports Club, are under a committee of employees. Our canteen, built at the request of the Ministry of Food, has proved invaluable. We also find that a break for a cup of tea at eleven works wonders. The Sports Club with its cricket field, its tennis courts, and, not least, its bowling greens for the elderly, is very popular. It reaches its greatest height on the annual sports day when thousands of our people and their families attend.

I have said nothing of Trade Union matters. I think most of our people are members of the Transport and General Workers Union. At any rate, the local representative of that Union, on the workers' behalf, from time to time amicably adjusts wages and working conditions, and the same applies to the Coopers' Union.

We have recently decided to introduce a five-day week for our staff and workmen. There have, of course, to be special arrangements for continuing processes over the week-end, but the committee of the directors, staff and workmen have been able to get over these difficulties and it will soon be all in working order. The first department in which this forty-four-hour, five-day week, came into force is giving a larger output than with the previous forty-seven-hour five and a half-day week, and there is a considerable saving in fuel. When I recollect making a contract for 500 tons of small coal a week at 3*s*. 3*d*. a ton delivered, and contrast it with the present price of ten to twelve times as much, saving in fuel is a very important matter.

At the end of our financial year I hope to hand over control to five young managing directors, each of whom has his definite department; but I do so with great gratitude to many old friends, to each one of whom a measure of the success of the company is due.

GENERAL NOTE

SCHOOL COMPETITIONS OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS.—The Royal Institute of British Architects annually offer prizes to a total of ten guineas in competitions for boys and girls in secondary schools, to encourage interest in architecture. There are two competitions, both open to those who have not left school before the end of the summer term this year. The first is for an original essay on a building or group of buildings, illustrated by sketches by the writer. The essay should display personal thought and judgment, and the competitors are advised to "choose a building they like and state their reasons for liking it". The other competition is for the best sketches or scale drawings of a building, or part of a building, in pencil, ink or colour. These must be drawn from the original, and any measurements made personally by the competitor. The quality of the building will be considered in awarding the prize.

Drawings for the two competitions must be sent through the headmaster or headmistress of the competitor's school to the Secretary, Royal Institute of British Architects, 66 Portland Place, London, W.1, from whom further details can be obtained. Entries for this year must arrive before October 7th, 1947.

OBITUARY

THE MAHARAJAH OF JODHPUR.—We announce with regret the death of Air Vice-Marshal His Highness Raj Rajeshwar Maharajadhiraj Sir Umaid Singh Bahadur, G.C.S.I., G.C.I.E., K.C.V.O., which occurred in India, on June 9th. Born in 1903, the Maharajah succeeded to his position in 1918, and assumed full power in 1922,

following a regency in his minority. His reign was marked by progressive measures in education, law, irrigation and land reform. He was also greatly interested in aviation, and was himself a pilot. The airport which he set up near Jodhpur became important in civil aviation, and later, during the war, as an air-training centre. In 1939 the rank was conferred on him of Air Commodore, and, in 1945, of Air Vice-Marshal. The Maharajah had been a Life Fellow of the Society since 1922.

JAMES AGATE.—We regret to announce the death, on June 6th, of Mr. James Agate, the well-known dramatic critic.

James Evershed Agate was born in Manchester in 1877, and was educated at Giggleswick and Manchester Grammar School. While working in the cotton trade, he practised dramatic criticism for several years before the first World War and was dramatic critic to the *Manchester Guardian* from 1907 to 1914. He served in France with a commission in the R.A.S.C. from 1915 to 1918. On his return after the War he came to London to embark on his subsequent career of writer and critic, which made him so widely known and produced the immense volume of entertaining and stimulating writing, both journalistic and published, on the stage, on films, on his interests and on himself. Fellows of the Society will remember that Mr. Agate delivered the Peter le Neve Foster Lecture entitled "A Moment in the History of the English Theatre" in November, 1945. He was elected a Fellow of the Society in April of this year.

FRANK HODGES.—We regret to announce the death, on June 3rd, of Mr. Frank Hodges, J.P., formerly secretary of the Miners' Federation of Great Britain. Mr. Hodges worked for many years for the trade unions and in the interests of the miners. Born in 1887, he started work himself in the Welsh mines, to which he returned after two years of study at Ruskin College with the aid of a scholarship. He took an active part in trade union affairs, and at 31 he was elected to the secretaryship of the Miners' Federation of Great Britain. In this position he had a large part in laying before the Sankey Commission the evidence for the need of betterment in the miners' conditions. He was a Civil Lord of the Admiralty in the Labour Government of 1924. Later he held the secretaryship of the International Miners' Federation, and was appointed a member of the Central Electricity Board. He had been a Fellow of the Society since 1937.

CORRESPONDENCE

"DISTRIBUTION"

In the paper on Distribution published in the June issue of the *Journal* Mr. Lloyd endeavours to meet the challenge, "That charges for distribution have been taking a toll of the industry far larger than is consistent with the National interest". So well does he appear to achieve his object that the reader is shocked by the closing paragraphs of his paper in which appears the remark, "Such statements are easy to make because there are no recognised standards by which to judge".

The yardstick that Mr. Lloyd is missing is admittedly more difficult of calibration for the retail trade than for industry, but until attained it is surely no good resenting "these vague and unsupported statements about the inefficient wasteful extravagence of distribution in this country". Indeed, however efficient distribution may in fact already be, it is reasonable to assume that the introduction of such a yardstick will have beneficial results.

(Lt.-Col.) E. MACA. YOUNG.

NOTES ON BOOKS

THE LIFE, WORK, AND SETTING OF PHILIP WILSON STEER. By D. S. MacColl. Faber & Faber. 1946. 25*s*.

"I shall live no more than I can record, as one should not have more corn growing

than one can get in". So writes James Boswell in his diary. To restrict life in accordance with the limitations of one's artistic faculties, is certainly the hallmark of one kind of genius. Of such a group Philip Wilson Steer makes one. Few modern painters have lived such an obviously unadventurous life as Wilson Steer, yet like Chardin, whose habits and movements were even more restricted, he produced fine work spreading, as it were, from a static centre. Mr. D. S. MacColl is to be warmly congratulated on presenting so rounded a portrait of an artist whose life presents few landmarks for the biographer.

Steer was not given to introspection, nor to discussing his way of life. Like his inseparable Tonks, he accepted it. His domestic background at Cheyne Walk, presided over by the famous Mrs. Raynes, and later by "Flo", completed by cats and the visits of Tonks, Moore, Gray, and other intimates, and protection from draughts and the ever-present spectre of the common cold—all this he took for granted as his right and proper *milieu*. Add to this his yearly painting expeditions to the country for three months, and you have the simple basic material of Steer's life. Not much corn growing, perhaps, but every ear carefully garnered and yielding its utmost. From this crop Steer distilled the essence of his painting, which we can see now to have been among the finest of its period.

There could be no better biographer for Steer than Mr. MacColl, contemporary and intimate, a consistent champion of Steer's painting, a modest but distinguished artist himself, and as a critic and Director of the Tate Gallery, a participant in the main artistic events of Steer's time. Mr. MacColl has drawn to a considerable extent on memoranda provided by Steer's friends and Slade pupils, and these provide intimate glimpses of the quiet and reticent character of the painter, of the sudden shafts of incisive wit, of his intolerance of "movements", cliques, "art boys", and the shams and shibboleths of the art world, of which Mr. MacColl joins with Steer and Tonks in contemptuous dismissal. Though Mr. MacColl does not stress it, there was an invincible Englishness and insularity about Steer, which stood him in good stead. (For some reason it is frequently thought derogatory to call an English painter by that name, or to stress his self-contained qualities. The French on the other hand, make no bones about their disregard for the art of other countries, and praise of a French painter for being French is a commonplace of modern criticism.) It was Steer's self-contained Englishness which stopped him from being unduly influenced by French painting, and thus enabled him to build in an essentially English way upon the English landscape tradition. Had Steer been willing to perfect his French, he might not have been dismissed from the *Ecole des Beaux-arts* in 1884. and the story might conceivably have been different. As it was , he never fell under the spell of what Mr. MacColl calls "the cult of Cézanne" (though he admired some of Cézanne's early work), nor did he abandon his landscape predilections for the cubes and arabesques of post-impressionism as propaganded by Roger Fry. It is true that there are early works in which French Impressionism is a manifest influence, such as the lovely " Yachts " in the Tate (1892), in which Steer experimented with divisionism. But if Steer was an impressionist then he was very much an English one, with his eyes on Gainsborough, Turner and Constable.

Upon this basis he painted his landscapes, astonishing in luminosity, bathed in gentle and romantic atmosphere, or deep with fast-moving clouds scattering their cool shadows across green meadows wet with recent showers. Even more personal than the oils, are his water-colours, comparable only with Chinese work, or with the monochrome water-colours of Claude. In this context Mr. MacColl quotes Mr. Vernon Wethered, "Someone from North Wales wrote to Steer for the loan of one of his water-colours as he wanted to know how to paint trees. Steer, instead, sent him a little book of reproductions from Claude's drawings, saying that was how he had learned himself". Mr. Wethered goes on to wonder how Steer, living nine months of the year in London, managed to paint such landscapes. The answer is surely that like Turner, he developed a tremendous visual memory, as one can see from the slight sketches from which some of the biggest oils were painted.

Mr. MacColl's chapter on Steer's paintings is full and attractively anecdotal. His account of Steer's portraits and figure pieces is welcome, for although predominantly a landscape painter he painted some fine portraits, warm human and intimate, and best exemplified perhaps, by "Mrs. Raynes" (Tate Gallery). Earlier portraits are Whistlerian, such as the exquisite portrait of Jennie Lee, but later they came into a closer relationship with the landscapes, with texture "all a-flutter, like a lady's fan" and a-glitter with reflected sunlight. But they were by no means deficient in psychological insight, as the reproduced portraits of Harvard Thomas the sculptor, and Croal Thompson, the dealer, make abundantly clear. They possess a spontaneity and vigour and grasp of masculine character which, as Mr. MacColl remarks "makes one regret that Steer was too occupied with the lovely sex to spend time upon the masculine". As to his pictures of women, Steer had in his make-up a baroque or even rococo streak. "The Pillow Fight", "Golden Rain", "The Toilet of Venus" and many others, show the artist not merely enchanted with feminine grace, but as heir to Boucher and Fragonard, in a technique reminiscent of Gainsborough's light touch (as we see it in "Bathers", in the Royal collection), yet markedly his own.

To Mr. MacColl's admirable account, Mr. Alfred Yockney appends a full catalogue of Steer's paintings in public collections.

LEONARD GREAVES.

CHARLES KEENE. By Derek Hudson. Pleiades Books. 1947. 18*s*.

There are still many people who, associating Charles Keene in their minds with that group of *Punch's* eminent Victorians which included Leech, Tenniel, du Maurier and Sambourne, are familiar only with C.K.'s wood-engravings which appeared more or less regularly in *Punch* for forty years after 1851. For them Mr. Hudson's survey of the life and art of Charles Keene, with a fine selection of C.K.'s original sketches for *Punch* reproduced in half-tone and other unpublished work, will be a revelation indeed; for the beauty of his original drawings—usually drawn on rough scraps of paper in diluted inks with strips of pointed wood—is unmatched in modern graphic art. That his unorthodox methods often defeated the skill and resource of the old wood-engravers goes without saying; but enough of the spirit of the original sketches was preserved in reproduction to win Keene countless admirers in his lifetime despite his reluctance to exhibit any of his original work. Whistler readily acknowledged his supremacy as a graphic artist, and his influence on the French impressionists was profound. Henry Tonks considered him by nature a painter, and the discerning appreciation of such distinguished artists as Tonks, Steer, Sickert and the Emanuels have certainly contributed as much as several unequal biographies to the posthumous reputation Charles Keene now enjoys.

Mr. Hudson's book provides an admirable introduction for those who have yet to discover Keene, but Somes Layard's bulky *Life and Letters* of C.K.—a "small beer chronicle" as he modestly called it—published soon after the artist's death, remains perhaps the most intimate and endearing portrait of the artist at work. Clearly from those pages (not quite so distinctly from Mr. Hudson's) there emerges the portrait of a most delightful and modest character, rather resembling Don Quixote in appearance with his tall figure, lined and melancholy face, and pointed beard. A bachelor, very fond of his clay pipes and the odd little meals which he prepared himself, he was an indefatigable worker, walking several miles a day to his London studio which was filled with miscellaneous collection of old weapons, gauntlets and other dusty relics.

Mr. Hudson has drawn freely on Layard's and later studies of C.K., added some fine unpublished drawings from Mr. Charles Emanuel's and other important private collections, as well as a few unpublished pastels and letters, and reproduced for the first time in colour the superb self-portrait in oils. The result is a most attractive book which will certainly make the reader eager to pursue the subject further.

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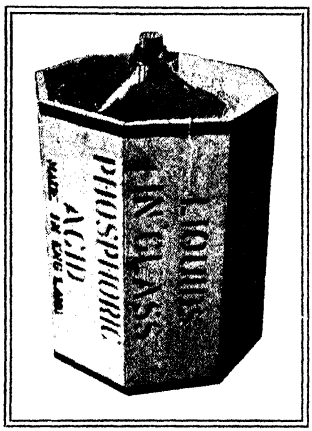
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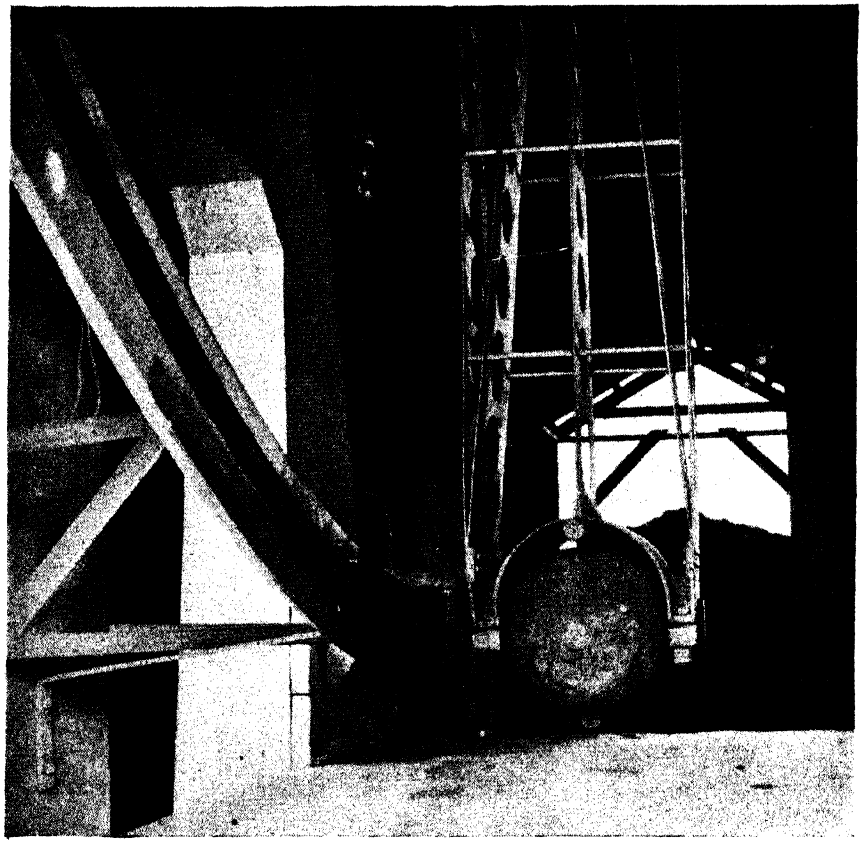
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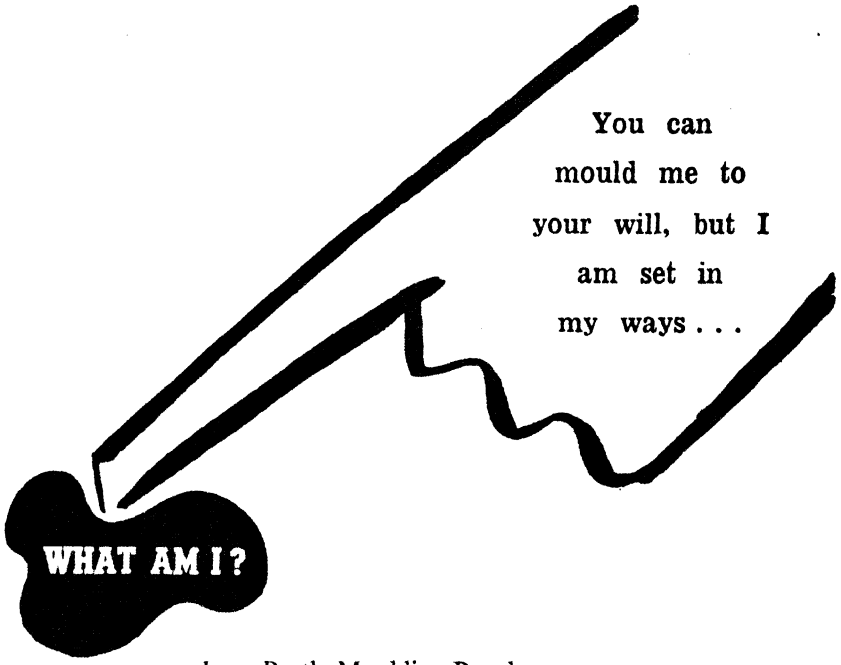
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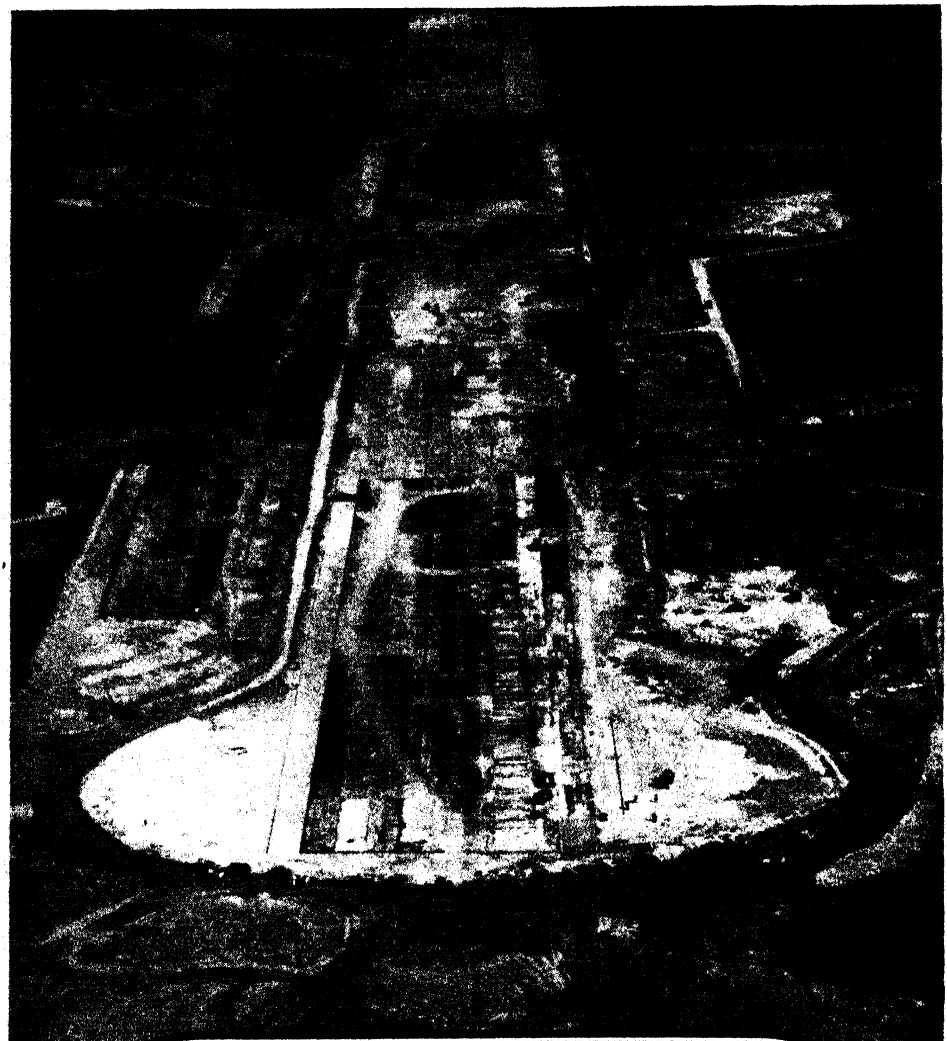
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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4746 *FRIDAY, JULY 4th,* 1947 Vol. xcv

DEATH OF PRESIDENT

It is with profound regret that we announce that VISCOUNT BENNETT, President of the Society and Chairman of the Council, died suddenly during the night of 26th June at his home at Juniper Hill, Mickleham, Surrey. An obituary notice will be published in the next issue of the *Journal*

Linlithgow Library.

THOMAS GRAY MEMORIAL TRUST

The annual examination for prizes for Junior Nautical Courses and Cadet Courses was held on June 11th. Five schools entered candidates, and 45 of these sat the examination, distributed as follows:

Leith Nautical College, Edinburgh	5
Royal Technical College, Glasgow	15
Nautical School, Kingston-upon-Hull	7
Sir John Cass Technical Institute, London	6
Marine School of South Shields	12

The prize of £5 for the highest marks in the paper on Mathematics, Navigation and Nautical Astronomy was won by Gordon Henderson, of the Royal Technical College, Glasgow, who also won the prize of £5 for the highest aggregate marks in the two examinations.

The prize of £5 for the highest marks in the paper on Science and General Knowledge was won by Thomas James Brow, of the Leith Nautical College, Edinburgh.

CHANGES OF STAFF

Miss Jean Scott Rogers, the Deputy Secretary for Special Services, has left the service of the Society for another appointment. Before being given the appointment which she has just resigned, Miss Rogers was Acting Secretary of the Society from January, 1943, to June, 1946, and prior again to that had been acting Assistant Secretary since October, 1940.

Mr. Charles Burns, the Assistant Secretary, has also left the Society and will shortly be assuming an appointment with the British Iron and Steel Research Association. In his place the Council has appointed Mr. C. J. Buchanan-Dunlop, M.C., M.A., a former Mathematical Scholar of Magdalene College, Cambridge. Mr. Buchanan-Dunlop served in the Royal Artillery from 1939 to 1946 and has, until recently, been Temporary Assistant Principal in the Ministry of Supply.

PROCEEDINGS OF THE SOCIETY

ONE-HUNDRED-AND-NINETY-THIRD ANNUAL GENERAL MEETING

WEDNESDAY, JUNE 25TH, 1947

VISCOUNT BENNETT, P.C., K.C., LL.D., *President, in the Chair*

The One-Hundred-and-Ninety-Third Annual General Meeting, for the purpose of receiving the Council's Report and the Financial Statements for 1946, and for the election of officers, was held in accordance with the Bye-laws, on Wednesday, June 25th, at 3 p.m., at the Society's House.

THE SECRETARY read the Notice convening the meeting and proved that it had been duly exhibited and published, as required by the Bye-laws.

The minutes of the last Annual General Meeting, held on June 26th, 1946, were taken as read and signed by the President as correct.

THE SECRETARY read extracts from the following Annual Report of the Council:

ANNUAL REPORT OF THE COUNCIL

193rd SESSION, 1946-47

I.—PRESIDENT OF THE SOCIETY

At the Annual General Meeting in June, 1946, the Right Hon. Viscount Bennett, P.C., K.C., LL.D., was unanimously re-elected President of the Society.

II.—THE ALBERT MEDAL

The Albert Medal of the Society for the year 1947 has been awarded to Sir Robert Robinson, M.A., D.SC., LL.D., F.R.S., Waynflete Professor of Chemistry in the University of Oxford and President of the Royal Society, "for his outstanding contributions to the advancement of organic chemistry".

III.—"ROYAL DESIGNERS FOR INDUSTRY" (R.D.I.)

The Council has this year made the following new appointments to the Distinction:

James Gardner, O.B.E. (Exhibition Design).
Robert York Goodden (General Industrial Design).
Ashley Eldrid Havinden (Commercial Art).

The Honorary Distinction has been conferred upon the following:

Professor Alvar Aalto (Finland) (General Industrial Design).
Professor Walter Adolf Georg Gropius (General Industrial Design).
Professor Steen Ejler Rasmussen (Denmark) (General Industrial Design).

Mr. Gordon Russell, C.B.E., M.C., R.D.I., has been elected Master of the Faculty of Royal Designers for Industry for the year 1947–48, in succession to Mr. Keith Murray, R.D.I., F.R.I.B.A.

During the year the Faculty has held several meetings and discussed future policy, including the possibility of holding a series of exhibitions.

IV.—FINANCE

As will be seen by the Accounts, the results of the year again show an excess of income over expenditure.

V.—REHABILITATION OF THE SOCIETY'S HOUSE

During the past year it has been possible to make considerable progress in the restoration of the Society's house from the damage which it sustained during the War. Last autumn most of the windows—including the beautiful roundheaded window over the doorway— were repaired and reglazed, and, in default of repainting, the exterior, entrance hall and staircase were brightened by the washing of the paint. In the meantime a licence was obtained for the repair of the lecture hall, and although various difficulties have had to be overcome, this work is nearing completion. The opportunity is being taken to effect some minor improvements under the guidance of Mr. Oswald Milne, F.R.I.B.A., and it is hoped that the hall will be ready for use in time for the opening of next session.

VI.—CENTENARY OF 1851 EXHIBITION

The Council have been much concerned during the past year with the plans for the celebration of the Centenary of the 1851 Exhibition. As a result of the report of the Ramsden Committee the Government had announced, in April, 1946, their intention to organise an International Exhibition in 1951. In his Inaugural Address the President announced a decision by the Council to offer a prize of £500 for an essay setting out the purposes which might be served by such an International Exhibition. Shortly afterwards, however, it became known that the Government were entertaining doubts regarding their previous decision. The Council thereupon appointed a Committee, under the chairmanship of Lord Samuel, which drew up a memorandum for submission to the Prime Minister. A little later the Committee attended an interview with Sir Stafford Cripps, the President of the Board of Trade, and submitted the reasons why, in the Society's view, it was in the national interest that in spite of the manifest difficulties such an exhibition should be held in 1951.

Finally, on February 6th, a conference was held at the Society's House at which well over a hundred national organisations of widely differing character were represented. At this meeting the proposal was freely discussed and a full report of the proceedings was forwarded to Sir Stafford Cripps. The Conference was almost unanimous in its approval of the proposal to hold an International Exhibition in London, but there was some difference of opinion as to whether the scheme would be practicable as early as 1951, and also as to the best site.

After receiving this report the President of the Board of Trade made a Parliamentary statement announcing that the Government had decided to postpone the proposed International Exhibition, but that the centenary of the 1851 Exhibition would be marked in some modified form. On consideration of this statement the Council have decided to keep Lord Samuel's Committee in being, so that they may be ready to take whatever action circumstances may suggest.

VII.—EXAMINATIONS

With the return from H.M. Forces of the remaining members of its staff the Examinations Department, now established at 28 Victoria Street, is restored to strength.

The total number of subject entries received for the Society's examinations to be held during the session 1946–47 (from November, 1946, to July, 1947) was 87,613, being an increase of 7,268 on the figures for the corresponding examinations in 1945–46.

This total was made up of subject entries for the various examinations as follows:

	1946–7	1945–6
(*a*) Ordinary examinations	73,227	67,020
(*b*) London County Council Grouped Course	3,053	2,988
Home Counties Grouped Course	2,473	1,933
(*c*) Examinations for employees of Road Transport Undertakings:		
Scheme "A"	347	280
Scheme "B" (held for the first time in 1946)	1,107	462
(*d*) School Commercial Certificate (March and July)	6,073	6,485
Senior School Commercial Certificate (July)	856	691

	1946-7	1945-6
(*e*) English for Dutch students	117	—
(*f*) Oral examinations (still in progress in various parts of the country)	450	486

The severe winter conditions and the subsequent flooding of many districts in the United Kingdom during March resulted in considerable interference with entries for the Easter examinations and to the examinations themselves. In consequence, a very considerable number of entries had to be transferred to the Whitsun and Summer Series of examinations.

Experience derived from the 1946 examinations seemed to indicate that, for a variety of reasons many Centres now preferred to present candidates at the Summer Series instead of at Whitsun, and the Time-Tables for 1947 were revised accordingly.

At the request of the London County Council and other Education Authorities the Grouped Course examination for students in London and the Home Counties was this year held at both the Whitsun and Summer series of examinations. Hitherto, only one Grouped Course examination has been held each year.

A certain amount of work is still arising from the Prisoner of War examinations, as applications continue to be received from many countries for results or certificates.

A full report of the Society's examinations during the past year, giving detailed statistics and a summary of the examiners' reports on the papers worked in the various subjects, will be published in the *Journal* in the autumn.

The Clothworkers' Company have generously continued their gift of money towards the cost of the Savings Certificates, which, for the present, take the place of silver and bronze medals awarded to the most successful candidates in the single-subject series of examinations.

VIII.—INDUSTRIAL ART BURSARIES

After a lapse of four years owing to the War, the practice of offering Industrial Art Bursaries was renewed in the summer of 1946. The Council, on the advice of the Bursaries Board, then decided that scholarships to the value of £150 each should be offered, from the Society's accumulated Bursaries Fund, to students in the Carpet, Furniture and Pressed Glass trades. In order to admit students whose studies had been interrupted by the War it was also decided to extend the age limits beyond those customary before the War, and the Competition was therefore opened to students of British Schools of Art or kindred institutions between the ages of 16 and 30 on October 1st, 1945. A full report of the Competition was printed in the *Journal* for August 30th, with illustrations of the winning designs.

The successful candidates are putting their awards to good use. Mr. Gerard Farmer, a student of Kidderminster School of Art, who was awarded a bursary in the Carpets Group, is now finishing a course at the Royal College of Art. Mr. L. J. Morton, a student of the Sir John Cass School of Arts and Crafts and of Birmingham School of Furniture, who won a Travelling Studentship in the Furniture Group, proposes visiting Denmark, Sweden and Finland within the next few months to study furniture design in those countries. The winner of the Scholarship in the

Pressed Glass Group, Mr. D. H. Simpson, a student of Stourbridge School of Arts and Crafts, is taking an industrial course with Messrs. Chance Bros., and will later travel abroad ; while Miss Joyce Wadsley, who was awarded a special grant of £50 for carpet design, is studying at Kidderminster School of Art.

This year, the Board are offering bursaries to the total value of £600 to students of the following subjects: Furnishing Textiles, Leather Goods, Wallpapers, and Open-Close Stove design. The full amount of the prize fund has been contributed by the industries concerned.

Several Travelling Scholarships which were awarded in 1939 but held over on account of the War are now being taken up by the winners, and the following students are planning to visit the countries stated this year:

Mr. Harry Booth—Holland, Denmark and Sweden.

Miss Victoria Higgs—Sweden, Denmark.

Miss Winifred Smith (now Mrs. Ives)—Denmark (Royal Copenhagen Porcelain Works).

Miss Joan Berry (now Mrs. Henderson)—Italy.

IX.—COMPETITIONS

(*a*) Colombo Cathedral

During the past year the Society has virtually completed the important task it undertook in November, 1944, as agents for the Bishop of Colombo in the organisation of a competition for a design for the projected new Cathedral at Colombo. Sir Giles Gilbert Scott has judged the 59 entries and awarded the first premium of £500 to Messrs. Pinckney and Gott, of London. The Bishop, while on a recent visit to this country, inspected the winning entry at the Society's House and expressed his warm approval of the design.

Details of the awards, and the Assessor's Report, will be found on p. 377 of the *Journal* for May 9th, 1947. The prize-winning design is reproduced in part on p. 410 of the issue for May 23rd.

(*b*) Competition for Designs for a Public Drinking Fountain

One-hundred-and-ninety-two designs were submitted in the Competition for Designs for a Public Drinking Fountain, and the first and second premiums, of £50 and £25, were awarded to Mr. C. G. Pinfold and Mr. Peter S. Ferguson respectively. Full details will be found on p. 643 of the *Journal* for September 27th, 1946.

(*c*) "Youth Looks at Britain" Poster Competition

Within the past twelve months the Society has organised a poster competition which has aroused considerable public interest. This competition was initiated by the National Association of Girls' Clubs and Mixed Clubs, and members of the British Travel Association subscribed the prizes, which totalled £620 in value. Eight-hundred-and-sixty-two designs were received and have been adjudged. (The results are announced on p. 540 of this issue of the *Journal.*) An exhibition of selected designs has been on view at the premises of the Travel Association.

X.—THOMAS GRAY MEMORIAL TRUST

The objects of this Trust, which was founded in 1924, are: "The advancement of the science of navigation and the scientific and educational interests of the British

Mercantile Marine." The following are the prizes offered and awards made under the Trust in 1946:

(a) AWARD FOR DEED OF PROFESSIONAL MERIT

One entry was received, which the Judges were unable to recommend for an award.

(b) PRIZE FOR AN INVENTION

Eleven entries were received during the year for this prize. The Judges were unable to recommend an award for any of them. Among the invention entries, however, was a description of a condenser system which was improvised and operated to supply fresh water in a ship's lifeboat after the vessel to which it belonged had been torpedoed. The apparatus was not considered suitable for an invention award, but the Judges would have classed it as a Deed of Merit had it not been ineligible for that award in respect of date. On the recommendation of the Judges, a suitable letter of appreciation was sent to the officer concerned, Mr. Gordon Murray, for his resourcefulness and ingenuity in the circumstances described.

(c) SCHOLARSHIPS FOR DECK BOYS AND YOUNG SEAMEN

During the year 1946 eleven candidates applied for these scholarships, which are administered by the Seafarers' Education Service, and five were accepted. This compares with ten in the previous year, though the number of inquiries received was almost the same.

A number of gratifying successes are reported of students who have taken the correspondence course provided by one of these scholarships and conducted by University College, Southampton.

(d) PRIZES FOR SHIPS' APPRENTICES

Fifteen prizes have been awarded as in previous years in connection with the examinations of the Merchant Navy Training Board. Five prizes are awarded in each year of seniority. Three candidates received sextants, six received binoculars, and six received telescopes. The number of apprentices and cadets coming within the scope of these examinations was 2,710.

(e) PRIZES FOR NAUTICAL COURSES

The annual examination for prizes for Junior Nautical Courses and Cadet Courses was held on June 11th at five schools. (A full report of the examination, with the results, will be found on page 518 of this issue of the *Journal.*)

(f) THOMAS GRAY MEMORIAL LECTURES

A series of two lectures on "Marine Life-Saving Appliances for the Merchant Navy and Fishing Fleet" was delivered by Capt. J. C. Taylor, on December 2nd and 9th, 1946, under the Trust.

(g) PRIZES TO TRAINING SHIPS

The Council awarded a prize of £5 to the training ship *Indefatigable* for the boy who, in the opinion of the masters and staff, possessed the qualities which will make the finest sailor.

(*h*) THOMAS GRAY SILVER MEDAL

The award of a silver medal to the candidate obtaining the highest marks in the examinations for the Ministry of Transport Extra Master Certificate has been revived. The recipient of the medal for 1946 is Capt. James H. Williams, of Blackpool.

XI.—WAR MEMORIALS ADVISORY COUNCIL

During the past twelve months the main endeavours of the War Memorials Advisory Council have been directed towards obtaining Government sanction for a National, or Imperial, War Memorial.

On January 22nd last, the President, Admiral of the Fleet Lord Chatfield, raised a Motion in the House of Lords drawing the Government's attention to the desirability of erecting an Imperial War Memorial in London, and requesting them to ascertain the feelings of the Empire in the matter. The First Lord of the Admiralty replied that the Government were not prepared to take any action until public opinion had shown itself to be strongly in favour of such a project and until a fitting scheme were produced.

The Council were not satisfied with this reply, as they felt it was the Government's duty to sound public opinion on such an important national question. A Special General Meeting of the Council was therefore held on April 30th, when it was decided to send a Resolution to the Prime Minister, briefly putting the Council's views before him and requesting him to receive a deputation to discuss the matter. Negotiations are now proceeding.

Throughout the year the Council's advice has been sought by local authorities and committees on various problems connected with their war memorials, and it is hoped that the guidance given has proved useful. Projected schemes have included Gardens of Remembrance, Victory Baths, Memorial Tablets and Panels, Cenotaphs, Military Memorials, Community Centres, Playing Fields and Rolls of Honour; while queries have been answered relating to War Charities and Income Tax, precedence of Army Units, building licences, military records and maintenance of a swimming pool.

It is clear that there is still need for an authoritative body in connection with War Memorial problems, and the Royal Society of Arts, in continuing to provide hospitality and support for the Advisory Council, is fulfilling one of those many useful functions which only an organisation of its unique character could appropriately undertake.

XII.—NEW COUNCIL

The Vice-Presidents retiring under the bye-laws are: Mr. Henry Berry, Lord Forrester, Mr. E. W. Goodale, Lord Horder, Sir Clifford Paterson and Sir Wavell Wakefield. To fill these vacancies and that created by the death of Sir Thomas Holland, the Council recommend: Major W. H. Cadman, Professor E. C. Dodds, Sir Thomas Dunlop, Mr. T. C. Dugdale, the Hon. Harold Nicolson, the Earl of Radnor and Miss Anna Zinkeisen.

The Ordinary Members retiring under the bye-laws are: Mr. W. H. Ansell, Major W. H. Cadman, Lord Latham and Miss Anna Zinkeisen. To complete the

list the Council recommend: Sir Alexander Aikman, Professor Andrade, Mr. E. W. Goodale and Mr. F. A. Mercer.

Mr. Gordon Russell, Master-Elect of the Faculty of Royal Designers for Industry, will fill the appropriate vacancy *vice* Mr. Keith Murray, the retiring Master.

XIII.—FELLOWSHIP

There has been a notable increase in the number of Fellows on the roll since the publication of the last Annual Report, the total being 4,395 (including 28 Associates), as compared with 4,026 (including 22 Associates) at the end of June last year. Many distinguished names have been added to the list, but in spite of this satisfactory position it is felt that Fellows would be rendering a service to the Society if they were to do more to bring its work to the notice of suitable candidates.

Publication of the revised List of Fellows was delayed owing to the fuel crisis, but it is hoped that the List will be available shortly.

XIV.—NEW ENDOWED LECTURES

(i) The recently instituted Cadman Memorial Fund provides for a lecture, to be delivered in alternate years, dealing with some subject connected with coal-mining, in commemoration of this aspect of the work of the late Lord Cadman. The first of these Cadman Memorial Lectures was delivered before the Society on March 19th, 1947, by Professor Douglas Hay, M.C., B.Sc., M.I.C.E., Chief Engineer, National Coal Board, with the Right Hon. Lord Hyndley, Chairman of the National Coal Board, presiding.

(ii) The first lecture to be delivered under the Selwyn Brinton Trust, which provides for lectures on Italian Renaissance Art, was given before the Society on Wednesday, June 11th, by Sir Kenneth Clark, K.C.B., Slade Professor of Fine Art, University of Oxford, who took as his subject "International Gothic and Italian Renaissance Painting". Professor T. S. R. Boase, Director of the Courtauld Institute of Fine Art, took the Chair.

XV.—MEDALS FOR PAPERS

The Council approved the award of 14 Silver Medals for papers read before the Society during the 192nd Session, details of which appeared in the report of the Inaugural Meeting in the *Journal* for November 22nd, 1946.

As an alternative to the medals, the Council have provided that those who gain these awards may, if they wish, receive books of their own choosing. The recipients will in any case be known as "Silver Medallists".

Consideration is now being given to the award of Silver Medals for papers read during the 1946-47 Session.

XVI.—PAPERS AND LECTURES

[*Page references to* Journal *reports are given in brackets*]

A.—ORDINARY MEETINGS

There were twenty-three Ordinary Meetings, at which a wide range of subjects was covered. In view of the primary importance at the present time of the grave economic problems which confront the country, the Council, at the suggestion of

Mr. A. C. Bossom, decided to devote a considerable proportion of the meetings to a series of papers on "Economic Reconstruction", at which various aspects of these problems were dealt with by speakers of great experience and authority. Another notable feature of the programme was a joint meeting with the Chemical Society in commemoration of the recent centenary of the first meeting of that Society, which was held in the House of the Royal Society of Arts in 1841. The commemorative address was delivered by Sir Harold Hartley and comprised a brilliant survey of chemical progress during the past one hundred years. As mentioned above, the session also included first lectures under two recently formed trusts, the Cadman Memorial Trust and the Selwyn Brinton Trust.

In view of a return to rather more normal conditions, the hour of Ordinary Meetings was changed, as an experiment, from the war-time hour of 1.45 p.m. to 5 p.m.

The full list of the meetings is as follows:

Chairman's Inaugural Address—The Right Hon. Viscount Bennett. (Pp. 7–15).

Trueman Wood Lecture—

MODERN ASTRONOMICAL INSTRUMENTS. *Sir H. Spencer Jones.*

Cobb Lecture—

THE DOCUMENTARY FILM. *Sir Stephen Tallents.* (Pp. 68–85.)

Peter Le Neve Foster Lecture—

THE HISTORY AND AIMS OF THE ARMY CADET FORCE. *Major-General R. E. Urquhart.* (Pp. 319–333.)

Sir William Jackson Pope Memorial Lecture—

SIR WILLIAM JACKSON POPE: HIS INFLUENCE ON SCIENTIFIC ORGANISATION. *Dr. L. H. Lampitt.* (Pp. 173–183.)

Cadman Memorial Lecture—

BRITISH COAL MINING AND THE INDUSTRIAL REVOLUTION: WITH SPECIAL REFERENCE TO THE LIFE AND WORK OF THE LATE LORD CADMAN. *Professor Douglas Hay.*

Selwyn Brinton Lecture—

INTERNATIONAL GOTHIC AND ITALIAN RENAISSANCE PAINTING. *Sir Kenneth Clark.*

Special Series of Eight Lectures on Economic Reconstruction—

(i) GREAT BRITAIN IN RELATION TO THE WORLD'S TRADE SITUATION. *Sir Charles Lidbury.* (Pp. 160–173.)

(ii) A SCIENTIFIC APPROACH TO LABOUR PROBLEMS. *Walter C. Puckey.* (Pp. 240–257.)

(iii) MATERIALS. *Dr. F. A. Freeth.* (Pp. 333–341.)

(iv) FINANCE AND THE USE OF MONEY. *A. H. Ensor.* (Pp. 346–358.)

(v) CRAFTSMANSHIP. *Reco Capey.* (Pp. 379–393.)

(vi) PRODUCTION. *The Right Hon. Oliver Lyttelton.* (Pp. 411–422.)

(vii) DISTRIBUTION. *E. J. B. Lloyd.*

(viii) BRITAIN'S ECONOMIC FUTURE. *Alfred C. Bossom.*

Other Papers—

FOG DISPERSAL. *A. C. Hartley.* (Pp. 22–43.)

EMBROIDERY AS AN EXPRESSION OF NATIONAL CHARACTERISTICS. *Miss E. Kay Kohler.* (Pp. 59–68.)

PLANNING RESEARCH FOR INDUSTRIAL DESIGN. *John Gloag.* (Pp. 118–133.)

THE GAS TURBINE, WITH SPECIAL REFERENCE TO INDUSTRIAL APPLICATIONS. *Sir Claude Gibb and Dr. A. T. Bowden.* (Pp. 265–317.)

A CENTURY OF CHEMISTRY. *Sir Harold Hartley.*

FLAX UTILISATION. *Dr. A. J. Turner.*

ELECTRICITY IN THE HOME. *Miss Caroline Haslett.*

GAS IN THE HOME. *Mrs. G. E. Abbott.*

B.—INDIA AND BURMA SECTION

Six meetings of the India and Burma Section were held, at which the following subjects were dealt with:

Sir George Birdwood Memorial Lecture—

THE VALUE OF GEOLOGICAL SURVEY IN INDIA'S ECONOMIC DEVELOPMENT. *Sir Lewis L. Fermor.*

Other Papers—

THE FRONTIER AREAS OF BURMA. *Brigadier J. F. Bowerman.* (Pp. 44–55.)

SOME SUPPLY ASPECTS OF REHABILITATION IN POST-WAR BURMA. *A. H. Seymour.* (Pp. 134–148.)

THE DOON SCHOOL. *A. E. Foot.* (Pp. 359–371.)

THE FORESTS AND FOREST RESOURCES OF INDIA. *Sir Herbert Howard.*

ROADS AND ROAD TRANSPORT IN INDIA. *Sir Kenneth G. Mitchell.*

C.—DOMINIONS AND COLONIES SECTION

Four meetings of the Dominions and Colonies Section were held, as follows:

Neil Matheson McWharrie Lecture—

RECENT AGRICULTURAL DEVELOPMENT IN CANADA. *Colonel J. G. Robertson.*

Other Papers—

THE WORK OF THE RHODES TRUST. *The Right Hon. Lord Elton.* (Pp. 393–405.)

WHITHER SOUTH AFRICA? AN ECONOMIC APPROACH. *Professor S. Herbert Frankel.* (Pp. 422–439.)

SOCIAL WELFARE IN THE WEST INDIES. *Professor T. S. Simey.*

D.—CANTOR LECTURES

The following four courses of Cantor Lectures were delivered:

SUPERSONIC VIBRATIONS AND THEIR APPLICATIONS. (Two Lectures.) *Dr. E. G. Richardson.* (Pp. 90–105.)

(i) THE ADVANCES OF MODERN SURGERY. (ii) APPLICATIONS OF RECENT PHYSICAL DISCOVERIES TO MEDICAL DIAGNOSIS AND TREATMENT. (Two Lectures.) *A. Dickson Wright.*

ENZYMES: THEIR ISOLATION, STRUCTURE, MODE OF ACTION AND PLACE IN NATURE. (Three Lectures.) *Dr. J. A. V. Butler.*

RECENT DEVELOPMENTS IN THE APPLICATION OF PHOTOGRAPHY. (Three Lectures.) *Dr. D. A. Spencer.*

E.—THOMAS GRAY MEMORIAL TRUST

The following course was given under the Thomas Gray Memorial Trust:

MARINE LIFE-SAVING APPLIANCES FOR THE MERCHANT NAVY AND FISHING FLEETS. (Two Lectures.) *Captain J. C. Taylor.* (Pp. 191–219.)

F.—DR. MANN JUVENILE LECTURES

THE CHILDREN'S HOUR. *Derek McCulloch.*

THE STORY OF GLASS. *Dr. J. H. Partridge.*

XVII.—THE JOURNAL

An increased allocation of paper made it possible at the beginning of the current volume of the *Journal* to revert to the pre-war size of type. Soon after, the fuel crisis, besides compelling the suspension of publication for a month—the first break in publication since the inauguration of the *Journal* 95 years ago—rendered the paper supply position once more very difficult. So far, however, it has been found possible to avoid any further drastic changes in format.

XVIII.—STAFF

(*a*) The Secretary returned to his duties on July 1st.

(*b*) Miss Scott Rogers, whose appointment as Acting Secretary terminated on the return of the Secretary, was given a new appointment as Deputy Secretary for Special Services, commencing on September 1st. In this capacity her duties included publicity, liaison with other societies and the less formal aspects of the relations between the Society and its members. She has now resigned this appointment in order to take up a post as personal assistant to Mr. Laurence Irving, O.B.E., R.D.I., and leaves the Society at the end of June, after a period of nearly seven years in the service of the Society.

(*c*) The last three members of the staff remaining on war service, Lieut. F. A. Wheeler, L.A.C. W. H. Rowlinson and Private C. Elton, returned to the Society's service last autumn.

(*d*) Several members of the war-time staff are remaining with the Society on a more permanent basis.

XIX.—OBITUARY

The Council record with regret the death of a number of Fellows during the past twelve months, among them being Sir Thomas Holland, a former Chairman of Council; Sir Humphrey Leggett, for many years Chairman of the Dominions and Colonies Section; Dr. F. H. Spencer, until recently the Society's Educational Adviser; His Majesty King Christian of Denmark; Sir Solomon Dias Bandaranaike; Sir Percy Bates; Alan E. L. Chorlton; John Downie Falconer; MacDonald Gill; Lady Helena Gleichen; Lord Kilmaine; Sir Manubhai Mehta; Harry Linley Richardson; Lord Salisbury.

XX.—THE SOCIETY'S PRINTING PRESS

The removal of the Printing Department from Lower Quinton, Warwickshire, to the newly-purchased premises at 67 Abbeville Road, Clapham, was completed in October last.

APPENDIX

STANDING COMMITTEES, 1946-47

Ex-officio members are indicated thus (*)

To save paper, distinctions after the name are given in the first instance only

FINANCE AND GENERAL PURPOSES COMMITTEE

Viscount Bennett, P.C., K.C., LL.D. (*Chairman*).
Major W. H. Cadman, M.B.E., B.SC., F.R.I.C., F.C.S., M.INST.CHEM.E.
Sir Atul Chatterjee, G.C.I.E., K.C.S.I.
Sir Edward Crowe, K.C.M.G.
Sir Edward Gait, K.C.S.I., C.I.E.
E. W. Goodale, C.B.E., M.C.
R. W. Holland, O.B.E., M.A., M.SC., LL.D.
Sir Harry A. F. Lindsay, K.C.I.E., C.B.E.
Sir Henry McMahon, G.C.M.G., G.C.V.O., K.C.I.E., C.S.I.
G. K. Menzies, C.B.E.
J. A. Milne, C.B.E.
E. Munro Runtz.
William Will, C.B.E.

PAPERS AND LECTURES AND MEDALS COMMITTEE

Viscount Bennett (*Chairman*).
F. H. Andrews, O.B.E.
A. C. Bossom, F.R.I.B.A., M.P.
Major W. H. Cadman.
Sir Atul Chatterjee.
Sir Edward Crowe.
Professor F. C. Dodds, M.V.O., D.SC., F.R.S.
E. W. Goodale.
Miss Caroline Haslett, C.B.E., COMP.I.E.E.
Sir Harry A. F. Lindsay.
Sir Henry McMahon.
Sir David Meek.*
G. K. Menzies.
J. A. Milne.
Keith Murray, F.R.I.B.A., R.D.I.
J. W. Ramsbottom, M.A.
A. R. N. Roberts.
E. Munro Runtz.*
Sir Frank Smith, G.C.B., G.B.E., F.R.S.
William Will.*
Miss Anna Zinkeisen, R.O.I., R.D.I.

INTERNATIONAL EXHIBITION COMMITTEE

Viscount Samuel, P.C., G.C.B., G.B.E. (*Chairman*).
Lord Aberconway, C.B.E.
Viscount Bennett.
A. C. Bossom.
Sir Atul Chatterjee.
E. W. Goodale.
Sir Ernest Pooley, K.C.V.O., LL.B.
Sir Thomas Holland, K.C.S.I., K.C.I.E., F.R.S. (*Deceased May*, 1947.)

INDIA AND BURMA SECTION COMMITTEE

Sir David Meek (*Chairman*).
F. H. Andrews.
Sir William Barton, K.C.I.E., C.S.I.
Viscount Bennett.*
Sir Frank Brown, C.I.E.
Sir Atul Chatterjee.
Sir John Clague, C.M.G., C.I.E.
Sir Henry Craw, K.B.E., C.I.E.
Sir Kenneth Fitze, K.C.I.E., I.C.S.
Colonel Stuart Fraser, C.S.I., C.I.E.
Sir Edward Gait.
Sir Lancelot Graham, K.C.S.I., K.C.I.E.
Lord Hailey, G.C.S.I., G.C.M.G., G.C.I.E.
Sir Kenneth Harper.
Edwin Haward.
Sir Thomas Holland (*Deceased May*, 1947.)
Sir Harry A. F. Lindsay.
Sir Hawthorne Lewis, K.C.S.I., K.C.I.E.
Sir Edward Maclagan, K.C.S.I., K.C.I.E.
Sir Henry McMahon.
Sir Alexander Murray, K.C.I.E., C.B.E.
Sir Frank Noyce, K.C.S.I. C.B.E.
Sir Samuel E. Runganadhan.
E. Munro Runtz.*
Sir Frederick Sayers, C.I.E.
Sir Thomas Smith, V.D.
Sir John Tait.
U. Saw Ohn Tin.
M. K. Vellodi.
Sir Alfred Watson.
E. A. Watson.
Sir Gilbert Wiles, K.C.I.E., C.S.I.
William Will.*
Sir John Woodhead, G.C.I.E., K.C.S.I.

DOMINIONS AND COLONIES SECTION COMMITTEE

Sir Harry A. F. Lindsay (*Chairman*).
Viscount Bennett.
Viscount Bledisloe, P.C., G.C.M.G., K.B.E.
Dr. R. M. Campbell.
Sir Atul Chatterjee.
Major Sir Humphrey Leggett, D.S.O., R.E. (*Deceased May*, 1947.)
F. L. McDougall, C.M.G.
Julian Mockford.
E. Munro Runtz.*
Noel Sabine.
Prof. J. L. Simonsen, D.SC., F.R.S., F.R.I.C.
A. Wigglesworth.
William Will.*

EXAMINATIONS COMMITTEE

Sir Edward Crowe (*Chairman*).
Viscount Bennett.*
Dr. R. W. Holland.
J. W. Ramsbottom.
E. M. Rich, C.B.E., F.C.G.I., B.SC.
E. Munro Runtz.*
Sir Henry A. Steward.
William Will.*

Appointed by Central Education Authorities—
England (Ministry of Education)—C. E. Beevers, H.M.I.
Welsh Department (Board of Education)—Dr. W. King, H.M.I.
Northern Ireland (Ministry of Education)—J. A. Glen, M.A.

Appointed by Local Education Authorities—
(L.C.C.), J. Brown, M.B.E., M.C., M.A., B.SC.
(L.C.C.), A. J. McIntosh, B.COM., PH.D.
(Birmingham), A. M. B. Rule, M.A., LL.B.
(Bradford), Thomas Boyce, M.A., B.SC.
(Croydon), H. A. Warren, M.SC.(ENG.), ASSOC.M.INST.C.E.
(East Ham), A. J. Jinkings, B.SC., PH.D.
(Halifax), B. R. Heasman, M.SC.
(Kent), E. W. Woodhead, M.A.
(Liverpool), A. R. Burnett-Hurst, M.SC.
(Middlesex), T. B. Wheeler, M.A.
(St. Helens), N. F. Newbury, M.A., M.SC., F.R.I.C.
(Surrey), R. Beloe, M.A.
(West Ham), E. A. Rudge, PH.D.
Association of Education Committees—A. W. Hoyle, B.SC.
Association of Directors and Secretaries for Education—J. Compton, M.A.

Appointed by Association of Governing Bodies and Principals of Technical Institutions—
Association of Technical Institutions—G. H. Austin, B.A., PH.D.

Appointed by Teachers' Associations—
Association of Principals of Technical Institutions—B. H. T. Matthews, B.SC., F.R.ECON.S.
Association of Principals of L.C.C. Commercial Institutes—D. Wilsden, M.A., LL.B.
Continuative Teachers' Association—W. T. Scales.
Association of Teachers of Technical Institutions—J. H. Harvey, B.COM.
National Union of Teachers—J. H. Wooldridge.

Appointed by Commercial and Professional Bodies—
Association of British Chambers of Commerce—Col. R. H. Goldthorp, D.S.O., T.D., J.P.
British Council—Miss B. Guavenall, PH.D.
Chartered Institute of Secretaries—A. Gale Johnson, F.C.I.S.
Federation of British Industries—W. Waterhouse Gibbins, M.A.
Institute of Bankers—Maurice Megrah.
Institute of Chartered Accountants—G. R Freeman, F.C.A.
Institute of Transport—F. W Crews, B.A., A.C.I.S
Society of Incorporated Accountants and Auditors—Walter Holman, F.S.A.A.

Co-opted Members—
H. L. Carrad, B.A., and L. A. Terry, B.COM.

Industrial Art Bursaries Board

Oswald P. Milne, F.R.I.B.A., (*Chairman*).
F. H. Andrews.
W. H. Ansell, M.C., PP.R.I.B.A.
E. J. Archer (Donald Bros., Ltd.).
Viscount Bennett.*
Cyril Carter (Carter and Co., Ltd.).
Sir Atul Chatterjee.
Sir Edward Crowe.
Dr. W. E. de B. Diamond, M.A., F.R.I.C. (British Plastics Federation).
E. M. O'R. Dickey, H.M.I. (Ministry of Education).
T. C. Dugdale, R.A., R.P.
Miss M. France (Marshall and Snelgrove, Ltd.).
E. W. Goodale.
A. E. Gray (Gray's Pottery).
James H. Hogan, R.D.I.
J. Douglas Hood (Wilson & Glenny, Ltd.).
J. A. Milne.
Sir Henry McMahon.
M. Gardiner Morris (Harvey Nichols and Co., Ltd.).
A. J. F. Morton (Morton Sundour Fabrics, Ltd.).
C. S. Newton (Carpet Trades, Ltd.).
H. E. Plaistow (Courtaulds, Ltd.).
A. B. Read, R.D.I.
Dr. G. Rudolf (British Celanese, Ltd.).
E. Munro Runtz.*
Gordon Russell, C.B.E., R.D.I. (Design and Industries Association).
Harold W. Sanderson.
Sir Charles Tennyson, C.M.G. (Federation of British Industries).
Allan Walton, R.D.I.
J. W. Waterer.
William Will.*

Thomas Gray Memorial Trust Committee

Capt. A. H. Ryley (*Chairman*).
Sir Westcott S. Abell, K.B.E.
Viscount Bennett.*
A. C. Bossom.
Lt.-Col. P. J. Cowan, M.B.E., M.I.C.E., M.I.MECH.E.
Sir Philip H. Devitt, BT. (*Deceased June*, 1947.)
James A. Edgar.
Capt. L. G. Garbett, R.N.
Dr. R. W. Holland.
Capt. J. H. Quick.
Capt. F. A. Richardson.
E. Munro Runtz.*
Sir Wavell Wakefield, M.A., M.P.
William Will.*

"R.D.I." Joint Committee

Appointed by the Council—
J. A. Milne (*Chairman*).
F. H. Andrews.
W. H. Ansell.
E. W. Goodale.
Sir Henry McMahon.
Sir Ernest Pooley.

Representatives of the Faculty for 1947—
S. Gordon Russell (*Master Elect of the Faculty of R.D.I.*).
Sir Francis Meynell.
Keith Murray.
R. D. Russell.
Miss Anna Zinkeisen.

Society's House Committee

Viscount Bennett.
J. A. Milne.
E. Munro Runtz.
Percy Delf Smith.
William Will.*

Membership Committee

Viscount Bennett.*
Sir Frank Brown.
Major W. H. Cadman.
J. A. Milne.
E. Munro Runtz.*
William Will.*

REPRESENTATIVES OF THE SOCIETY

The following are the present representatives of the Society upon the Governing Bodies and Committees of other organisations:

City and Guilds of London Institute (Council and Executive Committee of the Department of Technology)—Dr. R W. Holland, nominated by Chairman of Royal Society of Arts Council.

R.I.B.A Board of Architectural Education—A. C Bossom.

Architects' Registration Council Board of Architectural Education—Basil Ionides, F.R.I.B.A.

C.P.R.E. (Council)—J. A. Milne and G. K. Menzies.
C.P.R.E. (Panels Committee)—G. K. Menzies.
Chadwick Trust (Trustees)—E. M. Rich.
London Society (Council)—Lord Broughshane.
Soane Museum (Trustees)—Professor A. E. Richardson, R.A., F.R.I.B.A.
British Film Institute (Committee)—
National Film Library of the British Film Institute (Management Committee)—Sir Harry A. F. Lindsay.
Charing Cross Hospital (Life Governor)—Brigadier Sir Edward A. Tandy.
Institute of Physics—Sir Clifford Paterson.
Standards Committee of the Directorate of Post-War Building—F. H. Andrews.

THE PRESIDENT: It is my duty to move the adoption of the Report, and it will then be open for discussion. I will ask one of the Vice-Presidents to second the motion.

Sir HARRY LINDSAY: I beg to second the adoption of the Report.

THE PRESIDENT: The Report is now open for discussion . . . . I hope that the unanimity of the silence does not indicate a lack of interest. This has been a very interesting year. Some excellent papers have been read, and a great deal of useful information has been given to deserving audiences—at any rate, they suffered willingly!

I was very struck recently by the exhibition of posters entered for the competition organised by the Society, which made apparent what great talent is latent in this country. The young people took advantage of the competition and displayed very great talent indeed. I hope that you will have an opportunity of seeing some of the posters at the Travel Association's Bureau in Whitcomb Street. They are well worth your attention. The idea originated with the National Association of Girls' Clubs and Mixed Clubs, and they came to this Society to ask us to administer the contest. It was generally agreed that it was particularly well done, and we have every reason to be well pleased with the way in which the contest was carried on. The prizes, contributed by members of the Travel Association, were very large; £600 is a substantial sum to be contributed for that purpose; but I think that those who contributed realised that the money was well spent, because it secured visible evidence of talent which might not otherwise have been known. Some of the ideas of the young people were excellent, and the posters indicated not only draughtsmanship of a high order, but also imagination, and a realisation of the great pleasure that it is possible to give through the exercise of those faculties that are so much in evidence in good poster-making. The representative of one of the great steamship lines who contributed to the prizes was greatly taken with the results, and there will be some evidence on one of the great railway systems in their advertising of the value of this competition.

There were some excellent papers read during the year on problems connected with reconstruction. I think you will all agree that there are no problems more pressing, and none in which every individual in the country is more interested. It is only fair to mention that Mr. Bossom, who was going to the United States of America, took a very great interest and suggested the series. Every generation has great problems to solve, and this country has led the way in solving most of the

great problems that the world has had to meet. I think it is not too much to say that you are still doing so. You may lack some of the vigour and greatness of the past, because the world has become more settled than it was even twenty-five years ago; man has made progress, and the difficulties of solving the problems that now arise are greater than they used to be; but you are showing a capacity to deal with them, and that is all that can be asked of you.

The report in connection with the 1951 Exhibition is unsatisfactory, but it is only fair to say that the view which was taken and prevailed is a view which can be supported by very powerful arguments. Our shortage of materials and our shortage of manpower are factors which must influence the Government, who have responsibilities which sometimes the average elector does not appreciate. The extraordinary opportunities which the Government have for obtaining knowledge enable them to speak on some matters with greater authority than the average man. Sometimes we do not relish the terms in which they express their appreciation of the situation, but that is all part of the development of democracy. The important duty of this organisation is to try to see that the high standards which should prevail in an educated democracy continue to prevail. If they do not, there is a law of cause and effect, and the effect will be apparent from the exercise of the qualities of the cause. I think that perhaps everyone understands that, or is beginning to have a clearer appreciation of it.

I must be permitted, before I sit down, to say how great a thing it is that the people of this island have maintained in being organisations such as this Society. The value of it some of you, who spare some moments from your busy lives to come here, may find it difficult to understand. I was saying recently to one of our devoted members that there are no people but the British who show such sustained and steady interest in the development and continued usefulness of a Society such as this. You have led the way in maintaining these voluntary organisations that have made for themselves a reputation such that their commendation of any particular cause carries with it an authority that will be found nowhere else. When you think of the length of time for which this Society has existed, and of all that it has done, and when you see at the meetings of the Council busy men and women who do not regard it as too much to take some time out of their busy lives to devote to the good of the community as a whole and their fellow-citizens in particular, I think you will agree with me that you have every reason, you who are Fellows of this Society, for having maintained it in its present strength and for having seen to it that there are opportunities provided for men and women to make contributions through considered and carefully-prepared papers and through the conduct of business in the larger sense in a way that commends itself, I am sure, to all thoughtful people. Speaking for myself, and as a relative stranger, I cannot but feel that the world is a debtor to this country by reason of what has been done in that regard, which is little understood but which, fortunately, is better understood to-day than it has ever been before.

With these scattered observations, I trust that you will adopt the Report, and, unless someone is prepared to make a contribution to the discussion, I put to the meeting the motion that it be adopted.

The Report was adopted.

Mr. WILLIAM WILL explained some details of the accounts and moved their adoption.

Mr. E. MUNRO RUNTZ seconded the motion.

The accounts were adopted.

The new list of Council having been suspended in the Library in accordance with the Bye-laws and no additional nominations having been made, the President called on the Secretary to announce the Council for 1947–48, and the following were declared to fill the several offices. (The names in italics are those of Fellows who have not, during the past year, filled the office to which they have been elected):—

PRESIDENT

Viscount Bennett, P.C., K.C., LL.D.

VICE-PRESIDENTS

Lord Aberconway, C.B.E.
Lord Amulree, M.D., M.R.C.P.
A. C. Bossom, F.R.I.B.A., M.P.
Major W. H. Cadman, M.B.E., B.SC., F.R.I.C., F.C.S., M.INST.CHEM.E.
Sir Edward Crowe, K.C.M.G.
Professor E. C. Dodds, M.V.O., D.SC., M.D., PH.D., F.R.C.P., F.R.S.
T. C. Dugdale, R.A., R.P.
Sir Thomas Dunlop, K.C.M.G.
*Sir Edward Gait, K.C.S.I., C.I.E.
Miss Caroline Haslett, C.B.E., COMP.I.E.E.
Robert W. Holland, O.B.E., M.A., M.SC. LL.D.
Sir Harry A. F. Lindsay, K.C.I.E., C.B.E.
*Sir A. Henry McMahon, G.C.M.G., G.C.V.O., K.C.I.E., C.S.I.
*G. K. Menzies, C.B.E.
*John A. Milne, C.B.E.
The Hon. Harold Nicolson, C.M.G.
Sir Ernest Pooley, K.C.V.O., LL.B.
The Earl of Radnor.
E. M. Rich, C.B.E., F.C.G.I., B.SC.
Captain A. H. Ryley.
Viscount Samuel, P.C., G.C.B., G.B.E.
Sir Frank Smith, G.C.B., G.B.E., F.R.S.
John G. Wilson.
Miss Anna Zinkeisen, R.O.I., R.D.I.

ORDINARY MEMBERS OF COUNCIL

Sir Alexander Aikman, C.I.E.
Professor E. N. da C. Andrade, D.SC., PH.D., F.R.S.
F. H. Andrews, O.B.E.
Sir Frank H. Brown, C.I.E.
Sir Atul C. Chatterjee, G.C.I.E., K.C.S.I.
E. W. Goodale, C.B.E., M.C.
Professor C. S. Gibson, O.B.E., M.A., SC.D., F.R.S.
Sir William Halcrow, M.I.C.E., M.I.MECH.E.
Basil Ionides, F.R.I.B.A.
F. A. Mercer.
J. W. Ramsbottom, M.A.
A. R. N. Roberts.

ORDINARY MEMBER OF COUNCIL
(*ex-officio*)

S. Gordon Russell, C.B.E., R.D.I. (Master of the Faculty of R.D.I.).

TREASURERS

Mr. Munro Runtz.
William Will, C.B.E.

*Indicates President's Nominee.

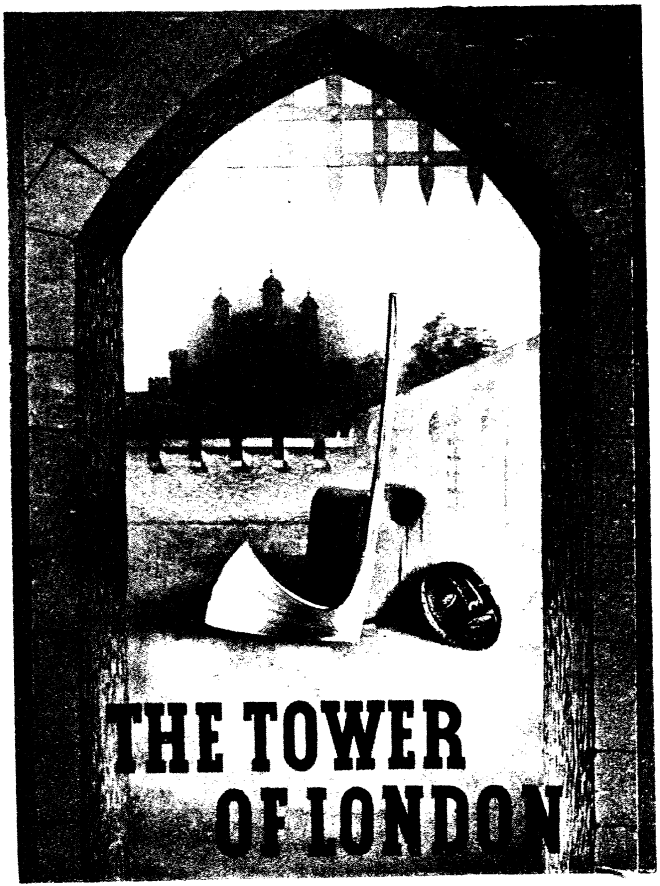
THE PRESIDENT: I desire to move a vote of thanks to the staff of the Society, who have done notable and difficult work during the past year. The war, of course, brought great difficulties to every organisation, and this one was not excepted. The manner in which the duties that devolve on the staff are discharged is known to all who have had anything to do with it. Most of the staff who were eligible for service left the organisation during the war, and their places were taken by a temporary staff, which made the work increasingly difficult; but the members of that temporary staff discharged their duties so excellently, and with such a high sense of obligation and responsibility, that the work went forward, I dare not say in the presence of Mr. Luckhurst quite as well as if he was there, but somewhat better at times!



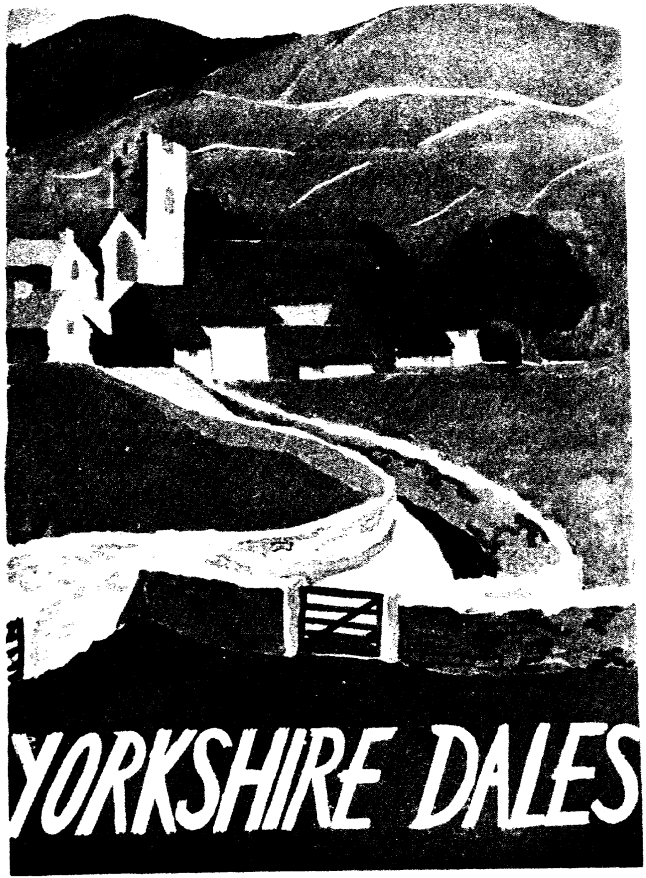
First Prize, Class A.2. (Travel, Youth Organisation, Age 19–20).
By Miss Betty D. Tyler



First Prize, Class B.3 (Entertainment, Art Schools, Age 16–18), and a Special Merit Prize. By Eric A. Thomas



First Prize, Class B.1. (Travel, Art Schools, Age 16–18), and a Special Merit Prize. By Brian D. Borthwick



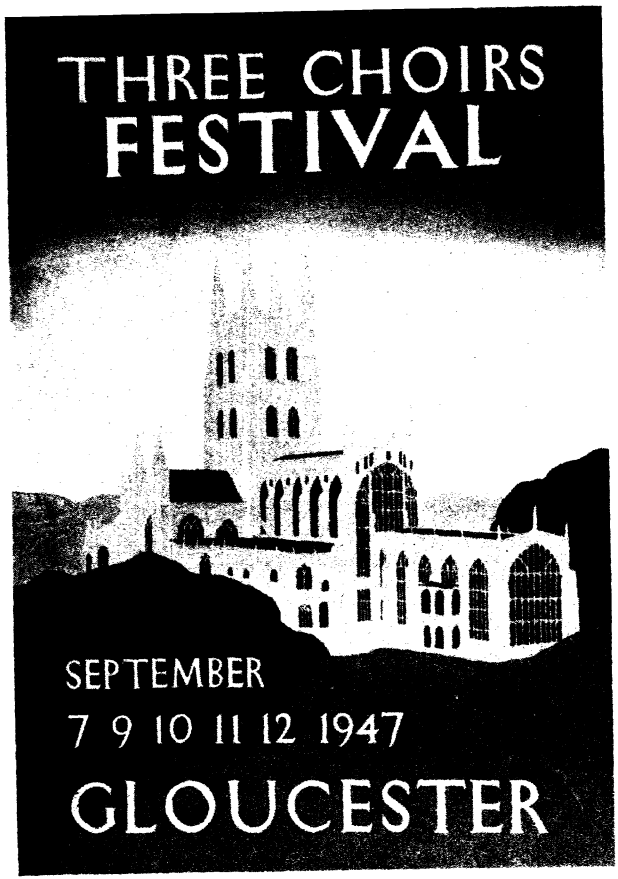
First Prize, Class A.1. (Travel, Youth Organisation, Age 16–18). By Dennis Smith



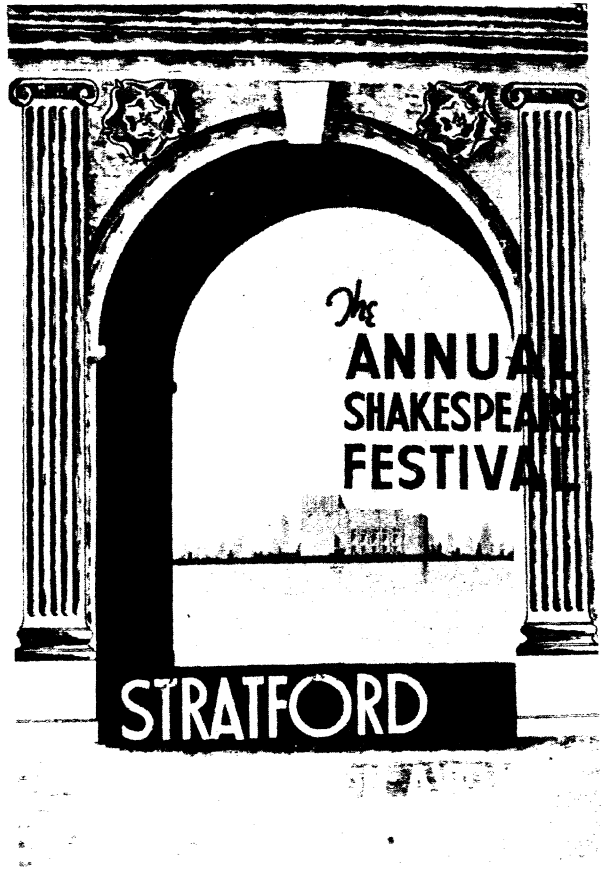
First Prize, Class B.2. (Travel, Art Schools, Age 19–20), and a Special Merit Prize. By Miss Gwendolen M. Knaggs



First Prize, Class C.1. (Travel, Other Schools, Age 16–18). By Timothy M. Roark



First Prize, Class C.2. (Entertainment, Other Schools, Age 16–18). By Michael B. Stevens



First Prize, Class A.3. (Entertainment, Youth Organisation, Age 16–18). By Alan Green

I should like you to reflect the mind of those who have the executive responsibility by expressing your approval by a vote of thanks being accorded by the Fellows to the staff of the organisation.

The vote of thanks was carried with acclamation.

THE SECRETARY: I thank you very much indeed on behalf of the staff for what you have been good enough to say. You have referred to the absence on war service of many members of the staff. I think that it is a testimony to the happy relations which exist between the Society and its staff, and I know that it is an indication of the affection which its servants feel for this old institution, that of the thirteen members of the staff who returned from the Forces, ten have come back to permanent employment with the Society. Another indication of the strong bond which is usually established between the staff and the Society is seen in the long service of some of them. Apart from the outstanding record of some of the very senior members of the staff, I think it is worth recording that during the present year two members of the staff have completed a quarter of a century's employment with the Society, and two others have reached their majority and completed twenty-one years, quite a remarkable record for a small organisation of this kind. Mr. Baker and Mr. Flanders have completed twenty-five years, and Mr. Samson, the Chief Clerk, and Mr. Barnes have both completed twenty-one years.

If I may take this opportunity of referring not to a return but to a departure, I should like to mention the resignation of a colleague to whom I am very greatly indebted, Miss Scott Rogers. I owe her a tremendous amount for all her support and assistance in the earlier days of the war, before I went into uniform. She was not only ever ready to help but always able to help in the most efficient way. While I have been away she has, to use a vulgar expression, "kept my place warm", as the President has said, so effectively that no one returning to a position of responsibility could have found it easier than I did to take up the threads. I almost feel as though I had never been away at all. Those, too, who have been here throughout the war have spoken of the way she helped them in their respective duties. We on the staff will miss Miss Rogers immensely.

I thank you, Sir, on behalf of the staff, for proposing this very kind vote of thanks, and the meeting generally for passing it.

SIR EDWARD CROWE: It is a privilege, and a very rare privilege, to be allowed to propose a vote of thanks to the President for the services which he has rendered to this Society during not only the past year but the year before that. Not only has he been a grand President, but he has been Chairman of the Council, he has looked after all our deliberations, and in addition to that he has been able to find time to devote to the day-to-day work of this Society, which takes up an incredible amount of time. Not only that, but with his diplomatic tact and with his great knowledge and experience he has looked after us in such a way that we have had no rows, no major crises, and in fact no disturbances whatever! It has been really a very happy ship, and that has been because we have had a first-class captain to look after us. That is why it is with the greatest pleasure that I propose a hearty vote of thanks to our President, and a vote of congratulation to ourselves, inasmuch as we are

going to have him as President not only for this coming year but, I hope, for many more years to come.

Sir HARRY LINDSAY: It is my very great privilege to second this vote of thanks. It is a little difficult to do so, because Sir Edward Crowe has expressed so well all that we feel about our President; but let me add one word. We are particularly proud of our President on account of his great Empire connections. He is the Grand Old Man of the Empire. I first knew him fifteen years ago at the Ottawa Conference, and his paper to the Society on Empire Relations will live for ever.

The vote of thanks was accorded with acclamation.

THE PRESIDENT: I am not entitled to the language used by Sir Edward Crowe. All I can say of the President is that he tried to do his duty, such as it was, but it was not as exacting as Sir Edward would have you believe. Sir Edward, when he was Chairman of the Council, did one of the greatest jobs in the history of the Society, and he seeks to draw a comparison by depicting what the job was in those days, when he rendered such distinguished service as Chairman, and trying to persuade you that it is the same now. He fails entirely, however, in his effort to do so!

I have derived a great deal of pleasure from this office. I had no intention of ever serving this Society in the capacity in which I do, and no thought that that might happen. It would not have happened but for a combination of circumstances with which the hand of death had a great deal to do. Any man from Canada who has an opportunity of serving a Society such as this must be proud to do so. This Society was founded when Canada was not even a country, when there were different provinces fighting amongst themselves, not consolidated into a Dominion. When you think that during all those years this Society has continued to function and is still strong to serve, you will realise that one who comes from Canada and who finds himself in the position which I am in now must be deeply grateful for the confidence expressed in him. To any vain man—and we are all vain—the real truth is that some expression of approval, even in the exaggerated language of Sir Edward Crowe, is always acceptable. One carries away the memory of it, knowing that it is a false memory and that it is but a kind expression on the part of those associated with one in the same job. Although I hope that I am intelligent enough to put a proper rate of discount on the exaggerated expressions of the mover and seconder, I am grateful to them. I hope that at the next Annual Meeting, when I shall not be presiding, because I think that I see my successor before me, I may have the opportunity, in chaste and elegant language borrowed from Sir Edward Crowe, of expressing our approval of him.

The meeting then terminated.

"YOUTH LOOKS AT BRITAIN": REPORT ON POSTER COMPETITION, 1947

INTRODUCTORY INFORMATION

In order to encourage artistic talent among the youth of Great Britain and Northern Ireland and to stimulate an interest in travel, a national poster competition

was organised by the Royal Society of Arts and the Travel Association of Great Britain. The competition was initiated by the National Association of Girls' Clubs and Mixed Clubs and had the support of most of the recognised youth organisations. The Ministry of Education, the Scottish Education Department and the Ministry of Education for Northern Ireland all signified their interest.

The subjects for design were: (*a*) an original travel poster to attract people to any particular locality in Great Britain, and (*b*) an original poster to advertise any forthcoming indoor or outdoor event or entertainment.

Competitors were classified into three sections, *viz.*, members of youth organisations, students of art schools, and pupils of day and boarding schools. Within the youth organisation and art school sections there were two age groups, one from 16 to 18 and the other from 19 to 20. There was only one age group (16 to 18) for the day and boarding schools.

Thirty-four prizes, of a total value of £620—either in cash or holiday vouchers—were offered by members of the Travel Association.

The Council of the Royal Society of Arts appointed the following Judges for the Competition: (*a*) *Travel Poster;* Cuthbert Grasemann; Anna Zinkeisen, R.O.I., R.D.I.; Fred Taylor, R.I., R.D.I., and R. A. L. Hartman (representing the Travel Association). (*b*) *Entertainment Poster;* Jack Beddington; David Low; Milner Gray, R.D.I., and R. A. L. Hartman (representing the Travel Association).

The number of competitors who entered in all sections of the competition was 789. Of these, 278 were members of youth organisations (220 in the 16–18 age group and 58 in the 19–20), 110 were students at art schools (89 in the 16–18 age group and 21 in the 19–20), and 401 were pupils of day and boarding schools.

The number of designs submitted was 862 (competitors were permitted to enter two designs if they so desired), divided as follows:

Travel Poster Section (16–18 *age group*)—	
Youth organisations	164
Art schools	59
Other schools	267
Travel Poster Section (19–20 *age group*)—	
Youth organisations	45
Art schools	10
Entertainment Poster Section (16–18 *age group*)—	
Youth organisations	81
Art schools	36
Other schools	161
Entertainment Poster Section (19–20 *age group*)—	
Youth organisations	24
Art schools	15

The competitors were drawn from 257 clubs or local groups of national organisations, 58 art schools and 213 other schools.

TRAVEL POSTER SECTION

REPORT OF THE JUDGES

Class A.1. Youth Organisations. Age group (i), 16–18 years inclusive

The First Prize of £25, presented jointly by Travco Hotels, Ltd., and Travco Camps, Ltd., is awarded to Dennis Smith, of the Rawdon Youth Centre, West Riding Association of Girls' Clubs and Mixed Clubs (N.A.G. & M.C.).

The Second Prize of a holiday voucher value £10, presented by The Workers' Travel Association, Ltd., is awarded to Miss Joan Blackbourn, of the Darlington and St. John's Branch of the Girls' Friendly Society.

The Third Prize of a week's holiday value £5, at the Highland Hotel, Fort William, or £5, presented by Polytechnic Tours, Ltd., is awarded to Patrol-Leader R. A. Maddox, of the 1st Welwyn Boy Scout Group.

The design awarded first prize in the above class shows selective simplicity in its colours. It depicts typical English scenery, and conveys a great sense of local atmosphere in its representation of the Yorkshire Dales.

Class B.1. Art Schools. Age group (i), 16–18 years inclusive

The First Prize of a fortnight's holiday for two at Prestatyn Holiday Camp, or a holiday voucher for £25, presented by Thomas Cook & Son, Ltd., is awarded to Brian D. Borthwick, of the L.C.C. Camberwell School of Arts and Crafts.

The Second Prize of £10, presented by "The American and Commonwealth Visitor", is awarded to John H. Cannaway, of the Southampton School of Art.

The Third Prize of a holiday voucher value £5, presented by The Workers' Travel Association, Ltd., is awarded to Robert J. Rae, of the Glasgow School of Art.

The first prize-winning design in this class also receives the Special Merit Prize for the best Travel Poster in the 16–18 age group. It has atmosphere and originality of the highest order. Although not purely in poster style it is excellently executed and is beyond a doubt the best entry in this age group.

Class C.1. Other Schools. Age group (i), 16–18 years inclusive

The First Prize of a holiday voucher value £25, presented by The Workers' Travel Association, Ltd., is awarded to Timothy M. Roark, of the Cranbrook School, Kent.

The Second Prize of £10, presented by A. W. Berry, Director, British Engineers Association (Inc.), is awarded to Brian D. B. Palmer, of Rugby School.

The Third Prize of £5, presented by Groves & Whitnall, Ltd. (Salford), is awarded to Timothy C. Potts, of Rugby School.

The compelling cheerfulness, originality and colour of the prize-winning design make it stand out in this group, and win for it the first prize.

The simplicity and strength of design and the legibility of the lettering of the design placed second make for a good poster, and it is indeed one of the best submitted in the whole competition.

Additional Special Merit Prize for the best Travel Poster in the 16–18 age group

£10, presented by Cunard White Star, Ltd., awarded to Brian D. Borthwick.

Class A.2. Youth Organisations. Age group (ii), 19–20 years inclusive

The First Prize of £50, presented by The Travel Association of Great Britain and Northern Ireland, is awarded to Miss Betty D. Tyler, of the Campaigners.

The Second Prize of a holiday voucher value £25, presented by Frames' Tours, Ltd., is awarded to Miss Elizabeth M. Worthy, of the Young Women's Christian Association.

The Third Prize of £10, presented by the Thameside Development Board, is awarded to Miss Evelyn Stoutzker, of the Youth Hostels Association.

The design awarded first prize in this class, has a good sense of colour and is particularly effective in composition.

Class B.2. Art Schools. Age group (ii), 19–20 years inclusive

The First Prize of a holiday voucher value £50, presented by The Workers' Travel Association, Ltd., is awarded to Miss Gwendolen M. Knaggs, of Luton School of Art.

The Second Prize of £25, presented by The Canadian Pacific Railway Co., is awarded to Robert D. Harding, of Wimbledon School of Art.

The Third Prize of a holiday voucher value £10, presented by The Workers' Travel Association, Ltd., is awarded to John N. Stafford, of Manchester Municipal School of Art.

The first prize-winning design in this class is also selected as the best Travel Poster in the 19–20 age group, and, therefore, also receives the Special Merit Prize.

It is easy to look at, is very simple in conception, has extremely good colouring, excellent execution, and above all is originality at its best.

The other designs submitted in this disappointingly small entry are hardly up to the same standard and the Judges found it difficult to award the second and third prizes.

Additional Special Merit Prize for the best Travel Poster in the 19–20 age group

£10, presented by Cunard White Star, Ltd., awarded to Miss Gwendolen M. Knaggs.

COMMENDATIONS

In addition to the above prizes, the Judges decided to commend designs by the following:

Youth Organisations (16–18 age group)

Bernard F. Baker, of the Campaigners.

Art Schools (16–18 age group)

Cyril Austin, of Gravesend School of Arts.

David J. Redmond, of Harrogate School of Arts.

Other Schools (16–18 age group)

Colin C. Branson, of Pontypridd County Grammar School.

GENERAL

The standard of the designs is well up to the expectation of the Judges, and many posters showed exceptional originality and merit. It was noteworthy that the best designs were simple in character and yet forceful in their appeal.

In comparison the Judges feel that the younger age groups did extremely well,

and were generally better than those of the older age groups, who may be affected by conscription.

The freshness and originality of many of the designs submitted by members of youth organisations emphasise the need for affording encouragement and facilities for art activities within the youth movements.

In the opinion of the Judges one of the most encouraging features of the Competition is the response from all over the United Kingdom, and especially from the members of youth organisations and students of day and boarding schools in the 16–18 age group.

ENTERTAINMENT POSTER SECTION

Report of the Judges

Class A.3. *Youth Organisations. Age group* (*i*), 16–18 *years inclusive*

The First Prize of £25, presented by The Automobile Association, is awarded to Alan Green, of the Y.M.C.A., Leeds.

The Second Prize of £10, presented by Friary Holroyd & Healys (Guildford), is awarded to Norman P. Seal, of the Pen Mill Youth Forum.

The Third Prize of £5, presented by The Camping Club of Great Britain and Ireland, is awarded to John R. Davies, of the Cymry'r Groes.

The designer of the first prize-winning entry in the above class set himself a very difficult task. He succeeded, however, in producing a most successful design which is in the true British tradition, and conveys the essence of its subject.

Class B.3. Art Schools. Age group (*i*), 16–18 *years inclusive*

The First Prize of £25, presented by Cox & Kings (Agents), Ltd., is awarded to Eric A. Thomas, of Beckenham School of Art.

The Second Prize of £10, presented by The Royal Automobile Club, is awarded to Ronald J. Smith, of the L.C.C. Camberwell School of Art.

The Third Prize of £5, presented by Brutton Mitchell Toms, Ltd. (Yeovil), is awarded to Miss Pamela E. Persson, of the Southport School of Art.

The first prize-winning design in this group also receives the Special Merit Prize for the best Entertainment Poster in the 16–18 age group. The design is ingenious and æsthetically pleasing, and the craftsmanship is good.

Class C.2. Other Schools. Age group (*i*), 16-18 *years inclusive*

The First Prize of £25, presented by Kodak, Ltd., is awarded to Michael B. Stevens, of Leighton Park School.

The Second Prize of £10, presented by the Harrogate Corporation, is awarded to David H. Lewis, of the Pontypridd Boys' Grammar School.

The Third Prize of a voucher value £5 for a holiday at a Blackpool hotel and a day coach-trip, or £5, presented by Care-free Holidays, Ltd., is awarded to James Coleman, of the Orange Hill Boys' School, Edgware, Middlesex.

The work submitted in this group was generally of a mediocre standard. There is a certain dignity in the design awarded first prize.

Additional Special Merit Prize for the best Entertainment Poster in the 16–18 *age group*

One week's holiday for two at a Butlin's Holiday Camp, value £10, presented by Butlin's, Ltd., is awarded to Eric A. Thomas.

Class A.4. Youth Organisations. Age group (ii), 19–20 years inclusive

The Judges consider that none of the work submitted in this section merits the giving of a prize, and they are, therefore, unable to make any award.

Class B.4. Art Schools. Age group (ii), 19–20 years inclusive

The Third Prize of £10, presented by The English National Council Development Committee, is awarded to John N. Stafford, of Manchester Municipal School of Art.

The standard of the work submitted in this group is generally low, and the Judges find it impossible to award the first and second prizes. The design awarded the third prize is an interesting attempt at symbolism which, however, the Judges feel, does not quite succeed, although exhibiting considerable technical competence.

COMMENDATIONS

In addition to the above Prizes the Judges decided to commend designs by the following:

Youth Organisations (16–18 *age group*)

Leonard Burgess, of the Beaver Road Youth Centre.

Douglas C. Bond, of the Feltham Youth Centre.

Art Schools (16–18 *age group*)

Michael T. Rand, of Bromley School of Art.

Miss Mavis Teed, of the L.C.C. Camberwell School of Art.

Alan F. Dodsworth, of the Birmingham College of Art.

Other Schools (16–18 *age group*)

Miss Anne E. Williams, of St. Felix School, Southwold.

Art Schools (19–20 *age group*)

Miss Patricia A. Lindsay, of Nottingham College of Art.

Miss Gwendolen M. Knaggs, of Luton School of Art.

GENERAL

The work in the higher age groups was not up to the standard reached in the younger—a result, in all probability, of the call-up of many who would otherwise have competed in the older groups.

The Judges were, however, pleasantly surprised to find much incipient talent, which they feel is a good augury for the future.

ECONOMIC RECONSTRUCTION

(VII) BRITAIN'S ECONOMIC FUTURE

By ALFRED C. BOSSOM, F.R.I.B.A., M.P.

Twenty-first Ordinary Meeting, Wednesday, May 14th, 1947

The Right Hon. VISCOUNT BENNETT, P.C., K.C., LL.D., President of the Society, *in the Chair*

THE CHAIRMAN: I welcome you here this afternoon, ladies and gentlemen, for you have an opportunity to hear a paper from a very distinguished member of this Society, a Member of Parliament and one of our Vice-Presidents. Some months ago he conceived

the idea of this series of papers dealing with Reconstruction. This is the final one, the eighth paper, in which he proposes to deal with the Economic Future of Britain.

I need hardly say to you, because I judge from the fact that you are here this afternoon that you are serious-minded and have a proper appreciation of the magnitude of the task that lies before us, that it is not an exaggeration to say that we have reached the very crisis of our fate, and the future of this country, either as a Great Power or as an interesting island in the North Sea visited by tourists, is at issue. I do not think the people of this kingdom thoroughly appreciate the magnitude of the task that lies before us or of the real issue that has to be decided, but every day I think we are becoming more conscious of it.

Mr. Bossom, who has just returned from America, said that as he walked here to-day he was struck with the fact that there were very few smiling people on the street. I dare say that must be your judgment, as well. "In Fifth Avenue", he said, "in New York, they are all smiling". They may well smile, for they have become the great creditor nation of the world and we have ceased to be a creditor nation, something of which, I fear, we have never properly appreciated the effect. Never in our long history have we ceased to be a creditor nation until recently. In the very early days it was a matter of less importance, but as the years passed it became more and more important, and in every part of the world our position as a creditor nation was apparent. That has ceased to be. Our debts are so great, so numerous, that they are staggering in their magnitude. We owe to countries that once we were proud to lend money to, and the possible embarrassment that that may cause to us must be apparent in view of the fact that in July we are supposed to establish the free exchange of the pound. Just what it is going to be worth is your guess as easily as mine, but that we will be confronted with a crisis unless almost a miracle happens is apparent to every thoughtful man.

Without standing between you any longer, I have great pleasure in introducing to you Mr. Bossom.

Mr. BOSSOM then read the following paper:

In preparing this, the last of the eight papers on Great Britain's economic future, one was continually conscious that the political party in control during the reconstruction period is bound to influence it greatly, but one has endeavoured to be free from political party bias, or from proposing any partisan ideology.

World conditions will both obstruct and aid, but few authorities will disagree that Great Britain's economic future depends almost entirely upon the skill, initiative, invention and industry of her own men and women, and the success or failure that attends their efforts will define materially the position we shall occupy among major powers during our lifetime, as well as the influence we shall be able to exert on world events. Equally, the standard of living of this generation will depend on this, and it may well determine not only our national existence but point the destination of those succeeding us.

It was with this serious situation in mind that the Council of the Royal Society of Arts, under the Presidency of Lord Bennett, decided to invite a leading authority on each of the seven pillars that so powerfully underpin our national prosperity to read a paper to the Society's members. And it was right that this should be done by the Royal Society of Arts, for the function of this Society is to foster and encourage the development of the Arts, Sciences and Commerce, and it is to be remembered that it was due largely to its initiative that the invaluable Exposition of 1851 was held in Hyde Park. Now, nearly a century later, some constructive and responsible suggestions by this same body are particularly appropriate, for our economic position is at this time so involved and critical that clarification is essential.

In the first of this series of papers our trade situation in the large was put under a commercial specialist's microscope, which automatically called for a similar detailed review of the scientific approach to the labour situation, followed by an intensive consideration of materials old and new and their possible different and wider uses from those formerly ruling. Craftsmanship, that characteristic always so particularly ours and to which our international reputation was largely due, came next, leading to consideration of the conditions controlling production and distribution. These papers were logically accompanied by one on finance and the use of money—probably the most vital of all considerations.

This paper ends the series, and endeavours to call attention to certain impressions developing from those expert studies, and to give some outstanding facts. Each author has, in his particular phase of the economic situation, unhesitatingly recognised the need for, and the possibility of, improvement and progress—indispensable if we are to climb out of the present slough. Equally, they have recorded substantial unanimity in a measured optimistic outlook for the future, provided that those qualities which gained us our former industrial greatness and sustained us through catastrophic trials are given full and fair opportunity to be exercised once more to the utmost of our national ability.

To be realistic about the situation, may I say in a brief understandable sentence that if we do not succeed in reorientating our national attitude we shall fail to maintain even the present drab scale of living, we shall be unable to buy the food needed to keep us in normal energetic health when the American Loan runs out, and unable to buy the raw materials to manufacture the goods by the sale of which we gain our means of existence.

To help us "buy time" at this vital stage the U.S.A. loaned us 3,750,000,000 dollars. This so far has been spent with a curious and not too cautious hand. We are now spending it at a rate of about 5,000,000 dollars a day, and by autumn more than half will have gone, yet we shall not be even half-way to regaining a self-sustaining position, and if we continue our present practices something akin to national bankruptcy may then have to be faced.

During the two wars and in the intervening period, we lost practically a quarter of our assets; roughly half of our shipping and about half of our foreign investments were wiped out. We are carrying vast burdens of foreign responsibilities in Germany and other places, and are paying for the largest peace-time Service force and the production of the raw material it requires. To meet these charges, the nation has been forced into an austerity existence. Workers are enjoined to work as never before but to refrain from spending, to live on the poverty line, pay the taxes, and lend the remainder to the Government! Wages, though apparently high, have become of little use, for, owing to rationing and controls for actual existence or living, any weekly income is worth only something between two to three pounds in real wealth as we formerly knew it. In these circumstances is it to be expected that men will overwork themselves?

And what do we find? The workers, having been told for years that if they worked harder they were only making profits for "the bosses", are now understandably frequently and successfully pressing for shorter hours and more pay, with little or no regard to the goods produced.

Here again we find there are approximately 2,000,000 Civil Servants—700,000 in the Government alone—almost entirely non-productive: this is 10 per cent. of the working population. Taking the full count, of these State servants—the armed Forces, police, fire service and professional people—each twenty of us must carry two Service members, half a munitions worker, and four civil servants; in short, each three producers must carry one non-producer.

All know that to get the best results workers must have the best possible working conditions and assurance of permanence of employment, a minimum of industrial fatigue and a fair and full share of the profits derived from effort. This means good houses and factories and the best available machinery. But about 35 per cent. of our houses have been damaged or destroyed and many factories also have been destroyed or damaged. Some of the remaining factories are not adapted to highest speed production and are not situated at the most advantageous place, according to the executive management, nor is mass-production machinery for peacetime needs being provided quickly enough.

Many people are seriously fatigued from war strain: no less than 40 per cent. of those between the ages of twenty and forty have expressed a desire to emigrate, according to a "Gallup poll", and, instead of the maximum number of hands being available to produce as much as possible, in addition to caring for an inflated Civil Service the Government's system of management, *viz.*, nationalisation and controls, entails an expanding field of white-collar workers in industry who do not produce anything we can sell abroad or use ourselves. It is axiomatic that departmental controls of industry always involve delays and difficulties in speedily seizing opportunities to meet foreign customers' demands.

As to the actual food we get to eat, its dreariness is beyond question. Men are not stimulated by it as they formerly were, and their wives hate queueing. The grumbling and under-nourishment inseparable from such a monotonous, starchy diet has resulted in making us a dejected, laughterless, languid and less-ambitious people. In no competing country is the population rationed to 3 oz. of butter, 8 oz. of sugar, 1*s.* 4*d.* worth of meat, 2½ oz. of tea, 2 oz. of cheese and a dole of bread.

Already something like 80 per cent. of the cultivable surface of our island is in the hands of the farmers, so we cannot expect to get much more of our food from internal sources. Also, we are already using more tractors in proportion to our size than any other country.

In an endeavour to help meet our obligations and try to ease ourselves of some of our terrific burdens, clearly we must use our one natural resource, coal, at its best possibility: we must buy raw material at the right price, produce the items required by the world and offer them in a sufficiently attractive form at the right time at the appropriate cost to the purchaser, to enable us to face and out-sell our competitors.

As there is small likelihood of obtaining new or materially increased sources of energy from water or from the atomic discoveries for many years yet, we must for some time to come rely upon our coal both for home use and for export.

This obviously means the utmost co-operation between labour, management and government. The shortage of labour to meet requirements is variously estimated by some even as being likely to last twenty years: we are now between six and seven hundred thousand short, to work out a fairly full and rounded production, and

facilities must therefore be made available to enable the workers we have to produce more to meet and make up the deficiency.

The latest record of our coal production is indeed depressing, for it is estimated that, of 185,000,000 tons produced nowadays, something like 20-25,000,000 tons is literally rubbish, with little or no calorific qualities whatsoever.

Coal is not only in short supply as now produced, but in its internal use we are both wasteful and extravagant. Central and district heating, which would improve health and save coal, are not being widely and rapidly applied: by no means all the new Government- and Local Authority-sponsored houses are equipped with the latest proved forms of insulation in walls, roofs, windows and doors, or with economical fuel-using stoves—and yet four such houses have to be built for every one built by a private owner. By readjustment a waste of certainly half the coal consumed in all new household grates could be avoided.

As to winning a high place among the world's producers: coal miners in several other countries cut twice, three or in some cases even five times as much as our own miners to-day. Of course, a number of causes contribute to this high foreign production, but unfortunately there are few hopeful signs here at home that under the present Government-guided scheme our own coal production will be stepped up rapidly. Modernisation of the mines is painfully needed.

Government schemes of bulk buying are not proving as economical as was direct purchase by individual experts of raw materials in their several trades. Present methods often prevent our manufacturers giving firm estimates for future delivery of finished articles. Futures are considered by some Government departments to be gambling and frowned upon, but world-wide trade has been built up upon this form of commercial exchange.

Should a Government official make a mistake when buying in bulk—and no one contends that serious mistakes have not already been made—the losses to our people are considerable. And, human nature being what it is, when a Government is known to be in the market for any commodity in bulk foreign sellers do not hesitate to attempt a hold-up in a way that was almost impossible with the system of individual buyers who once traded with them, each of whom was not only an expert, but if dissatisfied, capable of moving off to another seller who could offer better terms.

One of the chief causes of our manufacturing fame was the high quality of our goods, *i.e.*, craftsmanship. Here again, in the present endeavour to turn over quickly from war to peace, though the Government rightly attempted to speed the process, it would appear that those making the top decisions were not infrequently insufficiently acquainted with foreign markets and needs, and have caused many expensive delays and uncertainties. Seldom have our best designers with their latest ideas been called in to meet foreign requirements. Instead, our manufacturers have been largely induced to push on with austerity mass-produced articles which, though now being absorbed by purchasing countries, because their shelves are as yet by no means full, are not likely to continue in such demand. And judging by the quality production goods now being turned out by our competitors, it would be foolhardy to imagine that the demand for our goods will stand up to foreign competition when that gets into its stride. Go about Europe or America, compare

our goods—the goods themselves, their attractive packaging or alluring presentation—with those beginning to come out of foreign mills, and the result will be a rude awakening

The failure to appreciate the importance of quality and craftsmanship is not turning our ex-Servicemen into craftsmen, and this they must be if we are to regain the high reputation for British goods which could, and certainly should rightly have been, ours. Austerity production, to which we have been committed, creates men equipped to make austerity goods, but fails to prepare them to make better or craftsmen's articles.

Distribution adds a substantial proportion to our cost of production, and although manufacturers frequently handle their production successfully on a margin of less than 10 per cent. profit, the retailers' apparent profits—often contended to be due to Government-imposed and almost overpowering controls of raw materials and of many of the means of distribution—sometimes add up to 30 per cent. These charges include both profit and the many and various overheads, but some declare they are too high, though not infrequently much of this is brought about by the created additional charges beyond the retailers' control.

By the nationalising of transport, higher charges still are foredoomed to come accompanied by slower deliveries and increased difficulties in packaging and the return of empty containers, all of which cannot but add obstacles to general betterment for both the home and export situation.

It is recognised that we are an inventive people, and credit was readily given to those who during the War invented or discovered new materials and invaluable further uses for existing materials, and gained renown by inventing products that went far to bring the victory to the side of the Allies. Very many of these new and newly used materials are capable of being so applied in peace as well as war both in the factory and in agriculture.

Private people employed by private companies, firms and corporations, were invariably the geniuses who did this fine work. We can, with justice, expect these same-thinking men to continue to open fresh doors to opportunities yet undiscovered, if given freedom, and to find peacetime uses for what they have already produced. It is hard to envisage that should an employee invent or discover some prospective benefit in the organisation which was once a private enterprise and is now Government-controlled, that would, under Government guidance, be given authority to act nimbly and with understanding of the opportunity opened by commercial use of the new discovery, and with the vim and enthusiasm of our old-time foreign selling organisations. The time between the perfecting of the invention and bringing it into commercial use is none too quick at any time, but when this is to be determined by the hesitating hand of departmental control, there has been, and most likely always will be, a delay which to-day we cannot afford.

Commercial managements all over the country are steadily developing a state of disunity between themselves and the Government, because forceful initiative is looked upon with suspicion by so many departments; in fact, there is a marked tendency to attempt to turn the nation's senior and even lesser private industrialists into Civil Servants who will have to toe the line at the behest of an officialdom largely composed of former trade union workers or officials, or of theoretical

ideologists among whom managerial or high commercial executive experience is exceedingly limited.

Will many disagree that there is a perceptible and growing sense of uneasiness all over the country which does not tend to bring about decreased cost of manufacturing articles or selling them abroad? Uncertainty as to the future is always expensive in both time and money, and the Government's placards now being posted all over the country are not by any means allaying this uneasiness.

If we are to present our products to the world in a manner to induce their maximum purchase we must create some arresting form of show-window. As I mentioned, the Royal Society of Arts was instrumental in bringing to a reality the highly beneficial 1851 Exposition, but when the Government was pressed recently by members of the Royal Society of Arts Council to give its endorsement and beneficent aid towards the creation of a 1951 Exposition which had been at first approved, it was definitely refused; shortage of labour, shortage of wood, and other similar surmountable difficulties being given as excuses to justify this change of attitude.

No credit was apparently given to the fact that new materials are at hand with which the necessary buildings could have been largely constructed, and certainly would have been if enterprising experts had been given the opportunity. The great many plastics, the fresh treatment of metals, stress-skinned light concretes, the new chemically-aided mixtures that have quite new qualities, would go far to obviate these presumed limitations.

Failure to hold such an Exposition may well become one of the causes of national unemployment in the reasonably near future, particularly if we do not succeed in convincing the world of our continued ability to produce the best of the things they want.

The visitors to such an Exposition who would come to see what we have to sell, would bring in a not inconsiderable volume of much-needed money, by their personal expenditures alone. Foreign buyers, both for pleasure and on business, have always been a source of income to Britain. Members of the Government are frequently suggesting that such guests are to be encouraged. Yet when the great S.S. *Mauretania* brought over what is understood to be a record host from the U.S.A. on her returning maiden voyage, the special train announced to be bringing them from Liverpool to London was to be equipped with only third-class carriages. What an impression of poor quality to force upon these would-be customers!

Of course, if we cannot get the Exposition, and if no satisfactory substitute can ultimately be arranged, there is no reason why we should not endeavour to get our goods submitted to the inspection of prospective purchasers by some other means not yet proposed. There have been trade ships which travelled from port to port in the past, showing to citizens of countries visited types of goods made in the country of the ship's origin. Why could we not, under guidance of the various trade associations specially concerned, get two at least of our unneeded war-time aircraft carriers with their magnificent open decks and large interior open spaces, fill them with examples of our production and send them round the world as floating showrooms, staffed with competent salesmen.

Markets must be won and must be held, if we are to get on our feet again. The need for action is obvious. Soon the Bretton Woods Agreement must be faced. Though it may ultimately fail in its purpose, it can well inflict serious handicaps upon our national economy before the full implications have demonstrated themselves to such an extent as to cause its modification to be undertaken.

After reviewing these various prospects in Britain's economic future, one returns to the inalienable fact that we British, judged by our indisputable historical background, are a great nation able to weather a crisis in any form, and that as a nation we shall weather this one. But all fair-minded people will agree that there are most serious, indeed, vital, issues to be solved if we are to avoid disaster.

All of our people, if they will give a fair effort, are entitled on their part to a fair return; and further, all, whether Governmental, managerial, operative or otherwise, are entitled, if they do their share fully, to the means of keeping their families and themselves in a degree of comfort commensurate with the job they are doing; and to be able to do this all the year round.

Clearly, exhortations to workers to work harder have not and will not act as sufficient inducement to cause an entire change-over from physical lassitude to enthusiastic super-energy. The nation's highest technical and experienced knowledge must be given the opportunity of using all of its very best in all fields. Design, production, presentation and finance—all these in the easiest and most available forms must be co-operative, and the Government of the day must aid instead of hindering, and must helpfully guide a nation-wide effort, *and quickly*, for time and money are running out.

Over-taxation and over-control have brought about the termination of other empires. But with our national ability to face and overcome insuperable obstacles given the chance to do so, and with all the many means that we have being flung into the effort, I still believe we shall do what to-day appears impossible. But if we do not get all those who can contribute to work together willingly we may find the terrible warning of the Government's latest placard "We are up against it" a sad reality, and this might bring about a flight from the pound. In many countries to-day the pegged price of our money is not being maintained, and if this situation continues and increases, it will bring results that will be disastrous.

DISCUSSION

Mr. T. C. NORRIS: Is not the root of all our troubles, *viz.*, the lack of desire to work and the falling-off in craftsmanship, due to faulty education? We have spent a tremendous amount on education these last few years, and yet we do not seem to have succeeded in instilling into the individual the desire to create. Now one of the psychological results of individual creation and one which brings much happiness to mankind is to observe the results of one's own handicraft: what a person has done with his own hands or brain. It does not matter whether he is a crossing-sweeper or a porter, how menial the job is or how high it is in the mental sphere: all men have this power of observing, "Now that was my own particular creation and I feel a pride in it". If such ideas can be infused once more through our educational system it will bring back, in my opinion, a healthy desire for high craftsmanship and the urge for greater production in each individual.

Mr. A. C. BOSSOM: There is no question that there is to-day a lack of desire to create. No doubt lack of appropriate education may have been a part cause of that, but to-day there are many other contributing causes. The lack of sufficient nutriment is one cause.

Our total food consumption to-day is about 10 per cent. in bulk less than it was in 1939, but the gap that has been caused by the lack of the more nutritious foods has been taken up with starch, and that is not to be overlooked.

Another point is the lack of ability to get a reward with the money you earn. If a man earns £10 to-day he can only get about the equivalent of a £3 pre-war wage with it. Well, that induces no one to make a great effort.

THE CHAIRMAN: I personally would not arrive at the conclusion that faulty education has produced the present result. I think that our education before the War had prepared our people for a much better effort than they had ever produced before. The reason that craftsmanship has, to some extent, been discarded, lies in the fact that we have endeavoured to adopt mass production, and mass production spells less and less skill in craftsmanship.

May I also say to Mr. Norris my observation is that this is a very tired people. We have been through the greatest campaign that sons of men have ever had to encounter and had seven years of war conditions. Let there be no misunderstanding as to the extent to which we carried the load. We had financial and other assistance from many places, but our forty-five millions of people bore a part in the struggle which has not yet been properly written of and described, and when you see the figures compared with the sum total of what was done, they will amaze you.

Dr. MARIE STOPES: Why then, do we not tell America the truth: that but for us 30 per cent. of *her* cities would have been destroyed, and why have we not the right to send in to America a bill for half of the cost of restoring the cities in this country and a request that she should pay *her* debt to us?

Mr. A. C. BOSSOM: I feel your point is a very fine theoretical attitude; I do not think I can put it higher than that. Assuming the positions were reversed and any other country put in a bill to us, the question is, would we pay it? I can assure you, that the respect in which America holds Great Britain now is abnormal, and if we approach them in the right way they will be much more considerate than they are often given the credit of being likely to be. But you must never forget under any circumstances that between Buffalo and Denver, in the great centre of that country, people are living on their farms, doing their work and existing in their own way, and they do not think as you do about those things. I have here the *Readers' Digest* for April, and also an article from the *Atlantic Monthly*, which go over points you mention, but such articles by themselves do not convince a nation that they have to pay us a tremendous debt. They have money, and if you have money you do not go out of your way to give it away.

Their attitude towards us is amazing. I could not have stayed in America under the present circumstances if somebody had not most kindly paid my hotel bill as a present. If I bought things friends insisted on paying the bills. It was an embarrassing situation, but it is one thing to be generous like that and quite another to go to a nation and say, "We will pay you an abnormal amount of money because you have suffered". Americans know what we have done, but the great mass of the people there are in the central belt, and you could not convince those people easily—if ever.

THE CHAIRMAN: My friends, you might as well face the fact that politics is the deciding factor, both in the United States and in the British Dominions and this country; and as soon as these become political questions men throw themselves into one side or the other of the conflict. The result is that to-day you have in this country a condition that the Americans cannot understand. You cannot induce the American people, with free enterprise and initiative, to understand an old country such as this becoming a Socialist country.

Mr. F. G. CREED: Our lecturer has given us a very good lecture, but a very sad vision of the future. I suppose I risk being considered a crank, if I point out that there are very good reasons, quite apart from the fact that we fought this terrible war and had all these terrible losses, why we should be in the apparently hopeless condition we are in to-day. We have had thirty or forty years of secular education. Our people have no vision. One of the old Prophets said, very truly, "Where there is no vision the people

perish". What we, as a people, need to-day is a great vision. We have gone away from God. Our people will not worship now: they do not believe now. The Germans began to beat us fifty years ago. Their "higher criticism", too readily accepted here by press and pulpit, has gradually destroyed the faith and with it the spiritual force of our people, and poisoned our education. Thus our people have lost their vision.

I think we could take a more cheerful view of the situation if we considered wisely the fact that last year we spent well on for two thousand million pounds—more than twice the amount of the American borrowing—on things that we could really do without. Over seven hundred millions on drink, many more hundred millions on tobacco, racing, betting, pools, cinemas, and so on. We are really a rich people, but we are throwing away money on superfluities. We need not sit down and cry about the terrible state we are in; what we need is to have a vision, and to follow it.

Mr. A. C. BOSSOM: You have called attention to an interesting point of view. In my paper I endeavoured to give actual facts; I did not express opinions. There are undoubtedly a number of contributory causes to the present situation, but when you say we are a rich people, there, I am afraid, I cannot agree. We were a rich people, but I gave you the facts of what we have expended. We have not got that money to-day. The situation as regards drink and tobacco is a matter for Governmental policy if they wish to attempt it, but frankly that has got to be a political issue.

As to lack of vision, we were climbing up quickly in 1937, 1938 and 1939, but the War has upset us. There is no doubt that the highest belief in the Almighty is eminently desirable, but to-day although we have got to develop our education and we have got to enhance our belief in the Almighty, we have still got to face the real hard facts as they stand, and if we do not, the rest of the world will greet us as a defaulter.

Mr. G. A. HOSKING, F.I.A., A.T.I.I.: It has been suggested earlier this afternoon that we have lost our craftsmanship through mass production, producing an article which is not so good. I had the privilege yesterday of attending the British Industries Fair. I only had time to attend the Earl's Court section, but I must say I was impressed by the quality of the articles there. Maybe it is because I could only compare them with what I see in the shops, whereas most of the articles on show at the B.I.F. were for export, but I did feel that the standard of quality was up to pre-War standards. I should like to have Mr. Bossom's comments on that.

Mr. A. C. BOSSOM: I would agree with you it is up to pre-War standards, but not up to modern standards in some other countries. The packaging of goods, for instance, in America is really remarkable. I was deeply impressed recently as I walked along the various streets in Washington, in New York and in Chicago by the way they presented their products. We do not compare with them. There is no doubt that the relative attractiveness is not to be compared, and you would agree, if you saw their goods, that their mass production is better than ours. They have a profession in the States of industrial designers, which we are only beginning to create in this country and have not yet in full effect: the sooner we get ahead with this the better it will be for us. If you were go to there and see for yourself you would, I believe, concede at once the distance they are ahead of us in much that they produce.

Mr. G. W. PINGSTONE, F.I.A.: What this country needs is a "shot in the arm" to give it a stimulus, and the only one I can see which would be effective is a really appreciable increase in the standard of nutriment. From my experience in the Army, I have no doubt that that is the thing which gives one energy. You can work twelve, sixteen or eighteen hours daily if you have the food inside you.

Mr. A. C. BOSSOM: Exactly. With an engine, if you do not put coal or oil into it it will not go far.

Mr. M. P. FRANKEL: I was encouraged to hear you mention the fact earlier, my lord Chairman, that we had gone through a rather severe war that possibly had some effect upon our morale and national vigour and energy, because I had gained from Mr. Bossom's speech, perhaps wrongly, the impression that the cause of all our present discontents was to be laid at the door of our present Government. It is extremely

difficult to be non-partisan, I admit, but I did rather gather from Mr. Bossom that, from food and coal to the third-class compartments from Liverpool to London that he mentioned, and possibly, I suppose, the losing of the Ashes in Australia, all these things were the result of the fact that we have the Government that we have.

Does Mr. Bossom not think it at least possible that the lack of desire to work is fundamentally a result of people's experiences between the Wars; that a constant army of between one and two million unemployed does not tend to give people confidence; that the fact, as Sir John Boyd Orr showed, that something like 40 per cent. of our population was undernourished would not exactly give them that energy which has been mentioned so much from the floor and by Mr. Bossom?

In addition, I want to ask Mr. Bossom whether he does not consider that the experience of the last twenty years, as evidenced, for example, in the Reports of the Working Parties on Wool and Heavy Clothing—those are the ones with which I am conversant—shows that the responsibility for the fact that machinery is, in some cases, at least forty years out of date, the fact that new equipment has not been placed in those industries, the fact that our miners can only produce a fifth of the amount that American miners can produce, the fact that we cannot get full productivity, cannot be placed merely at the door of the Government, but must be placed fairly and squarely on the people who have controlled and conducted those businesses in the past. The Report on Wool showed that some factories were working with equipment forty to fifty years out of date, and I would suggest that no government, whatever its political complexion, can do much about that in a couple of years.

I believe that a great thing has happened in the coal-mining industry recently: confidence has been restored there; the miners think that they at least are getting a square deal, and I myself think production is going to rise, even with the five-day week. Does not Mr. Bossom think that if we can get a similar atmosphere in other industries, if people can be led to feel that they are working in the interests of the community and not merely for people more concerned with giving dividends to shareholders than with ploughing profits back into the business for re-equipment and modernisation, that that will provide the necessary "shot in the arm" that a previous speaker mentioned as being so vital and so fundamental, and that it will lead at last to a real bettering of the material conditions of the people of this country?

THE CHAIRMAN: We did not intend to convert this into a debate on politics; that was not the purpose of this gathering, but I feel I must reply to this.

Instead of talking about the benefits that are going to accrue from nationalising everything, we must realise the fact that in the end it gets down to the management of the business, and I put the other day to one of the Ministries this question: do you tell me you can manage the steel business better than the people who now own it?

Mr. M. P. FRANKEL: Yes.

THE CHAIRMAN: Well, that is an assumption of knowledge and capacity that is a little surprising. One has never heard of these men who are going to run it, and are they going to do much better than these ironmasters who have worked their way up from the lowest industries to the highest, and are, by the choice of their fellows, the best this country can produce? And your Working Parties, who were they? Are they better men than the men who own the industry? Were they more interested in its success than the men who own the industry? The trouble behind it all has been class consciousness and the raising of the issue between classes, and that is ruinous to any country.

Search the history of the world from its foundation till to-day. Great have been the mistakes of the people of this island, and they admit them, but in all history there has been no country that has produced such results as the people of this island. Think what we have done. Men, your ancestors, cleared the seas of pirates and made safe the commerce of the world. Your ancestors saw that men breathed free air and slavery was abolished. They made possible the enjoyment of liberty by the individual, and of that form of responsible government that was worked out by those who went before you. They have taught us that; that is their legacy, and if I had one wish it would be that

men would cease to believe that by creating antagonisms and prejudices you can advance human happiness. It cannot be done that way, and, of course, until we give a spiritual bent to our activities and realise that purely material things do not produce the results we aim at, we shall fail.

I deprecate getting into a political discussion, for I am a stranger in a strange land, and I think it would have been very wrong of me except for the observations my friend made here. I never forget the formation of the National Government in this country, and the day they realised that a common purpose had to be substituted for a political purpose. When that was done we, for the time being, saved the situation. The crisis is coming now, and the propaganda talk of my friend will go a very short distance in alleviating the conditions that will arise when we have not enough money to buy the food that we need unless we borrow it from somebody. That is the position this proud land will find itself in if we continue in the way we are going. You cannot get away from it: you must face it. We are spending our borrowed money to get enough to eat at the present minute, and if that is so what is going to happen when there is no more money in the kitty?

Well, you have had a very interesting discussion to-day, covering all the political views of various people. May it serve some useful purpose, but I doubt it, because the real issue is to get down to the common purpose and all be for the State and Nation without thinking too much of Party. Parties are essential and serve a great purpose, but the mere belonging to a party that enables you to hit your neighbour and say he should not have the money he has is very wrong. Such controls have been placed upon our activities that the question is whether or not we have prohibited ourselves out of existence so far as thinking is concerned, and acting. Let us go forward from this series of papers on Reconstruction having learned much, as I think we have, and thanking Mr. Bossom. I am sure any one of you would be pleased to move a Vote of Thanks to him. (The vote of thanks was moved and seconded.)

It is moved and seconded, Mr. Bossom, that you be thanked for conceiving this series of papers and for what you have done to-day, which, as you point out, is not intended to be an expression of opinion but rather a factual presentation of conditions as they exist. Who, by taking thought, can add a cubit to his stature? There is a limitation upon what we may do, but there is one thing we can do: we can have a common purpose, and that is the welfare and the happiness and prosperity of all the people in this kingdom, regardless of their political views, and a grim determination that come what will we will not die. We will not give up the struggle in time of peace any more than we did at Dunkirk. What we have done for the world we now do for ourselves. We reverse Pitt's words and say that having saved the world by our example we now save ourselves by our exertions. (Acclamation.)

The vote of thanks was carried with acclamation.

Mr. A. C. Bossom: I think—in fact, I am convinced—that this series would not be of the value I believe it will be if we had not had Lord Bennett here this afternoon to express a number of fundamental truths and principles that are going to be, I hope, recorded in the *Journal* of this Society, because when he speaks he does so from a life-long experience, Empire-wide, and from that knowledge there is very much that we can consider and be influenced by. He would not have said those things if he was not convinced they were right. Lord Bennett is one of the very few men left in this world who has no axe to grind, who wants nothing for himself. All he wants to do to-day is to try and leave the world, if possible, a better place than he found it. I know this from having had the honour and the pleasure of working with him on the Council of the Royal Society of Arts. May I say we have heard to-day from Lord Bennett something we shall all take away and ponder over, and having thought shall realise its great value to us in forming our opinions and decisions in the future.

I should like to propose a hearty vote of thanks to our Chairman to-day.

The vote of thanks was carried with acclamation and the meeting then terminated.

SERIES OF PAPERS ON ECONOMIC RECONSTRUCTION

The previous papers in the series on Economic Reconstruction have already appeared in the *Journal*, in the following issues:

(i) "GREAT BRITAIN IN RELATION TO THE WORLD'S TRADE SITUATION" .. .. No. 4736 Jan. 31st, 1947
By Sir Charles Lidbury, *Chief General Manager, Westminster Bank, Ltd.*

(ii) "A SCIENTIFIC APPROACH TO LABOUR PROBLEMS" No. 4738 Mar. 14th, 1947.
By Walter C. Puckey, M.I.P.E., *Director and General Works Manager, Messrs. Hoover, Ltd.*

(iii) "MATERIALS" .. .. No. 4740 April 11th, 1947
By F. A. Freeth, O.B.E., D.SC., PH.D., F.R.S.

(iv) "FINANCE AND THE USE OF MONEY" .. .. No. 4741 April 25th, 1947
By A. H. Ensor, *Chief General Manager, Lloyds Bank, Ltd.*

(v) "CRAFTSMANSHIP" .. .. No. 4742 May 9th, 1947
By Reco Capey, R.D.I.

(vi) "PRODUCTION" .. .. No. 4743 May 23rd, 1947
By the Right Hon. Oliver Lyttelton, D.S.O., M.C., M.P.

(vii) "DISTRIBUTION" .. .. No. 4744 June 6th, 1947
By E. J. B. Lloyd, B.A., LL.B., *Director and Secretary, Lewis's Investment Trust, Ltd.*

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Volume XCIV ended with the issue of November 8th, 1947.

NOTES ON BOOKS

WEALTH FROM WASTE (Survey before Plan No. 3). Edited by M. George. Lund Humphries. 6*s.*

Survey before Plan No. 3—*Wealth from Waste*—edited by M. George, makes a very welcome appearance. It is a comprehensive little volume, beautifully laid out, and printed with taste and skill, and the photographs are particularly well chosen. If the diagrams seem a little technical, and therefore a little tiresome, for the general reader, it is difficult to see how this could have been avoided. The universal importance of the theme to Government, Local Authority, institution, hospital, school and private person at the present time could hardly be exaggerated: the correct use of wastes of all kinds under modern conditions is a question fundamental to civilisation itself.

The introduction to *Wealth from Waste* explains concisely the purpose of the enquiries undertaken by the A.P.R.R. (Association of Planning and Regional Reconstruction): "to distinguish between the disposal and utilisation of . . . . waste, to discuss existing methods of disposal and utilisation, and to recommend fuller utilisation". The present book, which is compiled, and very ably compiled, from a series of reports and broadsheets, suggests that realisation of the full implications and the urgency of the problem increased while studying it. The case for the utilisation of both house refuse and sewage sludge is convincingly developed.

The presentation of the case for organic manure is adequate. It is a summary of evidence at the planner's disposal, but it is far from complete. Moreover, the subject does not lend itself easily to generalisation, although generalisation in this case forms the best, and perhaps the only possible introduction to it.

An example of the kind of generalisation referred to is the section on Mycorrhiza (page 40). In the intimate relation between soil and plant many factors—chemical, biological, geological (to indicate only a few)—are concerned. The complexity of plant nutrition is by no means an open book: indeed much valuable work in this connection is being done at the present time, work on the *Azotobacter* association, upon the availability of manganese, upon the synthesis of plant protein. The mycorrhizal association will take its place in the picture without a vestige of doubt, but as yet the complete picture is not discernible. If one wished to cavil at so successful an exposition of fact in general one might suggest that the writer says at once too much and too little.

There is only one sentence in the whole book to which I must take exception. It occurs on page 57, and runs: "Some experts object to the Indore Process on the ground that it employs an aerobic technique and encourages fly breeding". *No* expert, to my knowledge, has voiced an objection of this kind. The very essence of the Indore Process is that, following Nature's lead on the floor of the forest, humus-making should be done under aerobic conditions. In fact, good aeration is a *sine qua non* of success. As to flies, no one who has ever mastered compost-making by the Indore Process is troubled with flies: the high temperatures preclude the possibility. The presence of flies in a compost heap betrays the tyro, not the expert!

SIR ALBERT HOWARD.

THE VISUAL ARTS. Survey by The Arts Enquiry. P.E.P. Oxford University Press. 1946. 10*s*. 6*d*.

Mr. Raymond Mortimer has recently written in the columns of *The New Statesman and Nation* that we are faced in the near future with the virtual extinction of the artist, and Mr. Wyndham Lewis has confirmed this in a recent broadcast. Perhaps such an alarming statement has been too frightening for some, too sweeping for others, certainly not loud enough nor sufficiently reiterated to penetrate public opinion. Perhaps too, one should add that it has not penetrated the official mind, for there is little sign of official recognition of this fact. That it is a fact, this admirable and complete survey makes abundantly clear. Furthermore, it provides, concisely and readably, chapter and verse for the assertion, an estimate of the causes, and suggestions for arresting the decline. Nor is this all, since it also concerns itself with investigating the present position in commercial art and industrial design, art education and art publications.

The Visual Arts is the most authoritative and comprehensive report of its kind yet produced. The enquiry was sponsored by the Dartington Hall Trustees, and the co-ordination of the separate sections of the report entrusted to a distinguished committee, including Mr. H. L. Beales, Professor G. D. H. Cole, Professor B. Ifor Evans, and Dr. Julian Huxley. "The real authors of the report", states the Foreword, "are a group of fourteen experts . . . artists, designers, gallery directors, art critics, art school principals, teachers of art, and secretaries of art societies". The report is dedicated to the late Christopher Martin, whose conception it was. Finally the publication is sponsored by Political and Economic Planning. In such circumstances it would be superfluous to doubt the authority of the enquiry, and in fact the findings dispel all doubts.

To read this report is to abandon all complacency about the administrative, educational, or economic aspects of art in this country. It is to realise that an anomalous situation exists whereby the State and the municipality, and therefore the ratepayer, spends thousands of pounds every year upon the teaching of art and art appreciation on the one hand, while the end products of art become fewer and less heeded on the other. Local Education Authorities maintain 235 art schools, and others are maintained by the Ministry of Education, universities, academic bodies, and privately. On them a great deal of public money is spent. Students are trained to become practising artists. When trained they are cast off, and told in effect to earn their livings in other ways as neither the State, the municipality nor the public has more than a very limited use for their productions. In fact, a large number of these artists are absorbed by secondary school teaching, and a smaller number by the art schools, where they teach other students to

become artists, but who actually become teachers, teaching others to become teachers. As producing artists they become the negligible band of Sunday painters. As the report rightly stresses, creative work calls for a high degree of concentration and energy, and the great art of the past was not produced in spare moments. Yet in the last census 10,000 people described themselves as artists. Discounting those employed by industry and for many of whom the term would be a misnomer, the rest would be amateurs or enjoying a private income. The report points out that in actuality not more than 700 painters and thirty sculptors earn their living from the work which they were trained to do, for which they have a natural vocation, and by which they make their greatest contribution to society. And even of this number how many could really be called creative or original artists? Artists of this high calibre able to support themselves above the standard of a modern agricultural labourer could, I believe, be counted on my fingers. The fact is that to-day the artist may earn a living from writing about art, teaching art, broadcasting on art, lecturing on art, and anything but by producing art itself. Yet without this, the teaching and appreciation of the subject, however supported and encouraged, is a mockery. In other words, the written or spoken word, or the reproduction, is of greater interest to society than the work of art itself. As Carl Spitteler says in his novel *Imago*, "If two doors were opened to them, one to Paradise and the other to a lecture on Paradise, they would all choose the second door".

It is natural to single out the position of the painter and sculptor from this report, since the fine arts form the cornerstone of the edifice of design, and as the survey reports, are the inspiration of all artistic training. The continued existence, not to mention security, of the painter and sculptor, is the obvious test of our concern as a nation for the arts. The report covers most cognate aspects of the subject, and its findings on art schools, art teaching, municipal galleries and museums, the national collections, and the private gallery as an intermediary between artist and public, are both revealing and depressing, though full credit is given to those societies and individuals who are doing valuable work. It may be useful to summarise the conclusions of just two important sections, the provincial art schools and the art galleries.

With certain notable exceptions, the provincial art schools art distinguished for the inadequate financial support of their local authorities, inadequate accommodation and apparatus, and poor cultural background locally. The insistence on cheapness for the full-time teacher does not make the most of teaching talent, and leaves out the essential services of the practising painter or designer who is not encouraged to settle in the provinces by niggardly rates of pay. Lack of co-operation with local industry, for which industry is often to blame, is the rule rather than an exception. Conditions will no doubt now improve as the Ministry of Education extends its regional schemes and industry realises more and more its dependence upon adequately trained designers.

The report also exposes the inadequacy of the municipal art galleries, which are all too frequently improperly staffed by unqualified individuals, or where salaries are impossibly small, and where curators have little or no grant for acquisitions, least of all for contemporary work. Even the Tate Gallery is worse off than any national collection has any right to be, and, since this report was written, has now and for the first time received from the Treasury a tiny grant for acquisitions—not all of which may be spent on modern work.

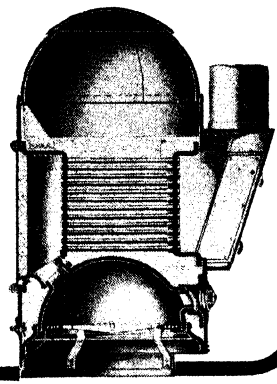
Finally, the report recommends the establishment of an Arts Council and an Industrial Design Council with wide powers and adequate finances. In fact, two such bodies were established by the Government before this report was published, but of the former at least it may be said that its powers and its finances are on a much smaller scale than the report indicates to be minimal. So far very few painters and sculptors have benefited by more than a very few pounds a year by its activities, which are unfortunately largely educational. This, it is clear, "is not enough". In the interim, what can be done? Like Mr. Mortimer, I would strongly urge everyone to buy a painting, however, modest, or a least to send their guinea to the Contemporary Art Society. To the members of such tasociety as this, I feel confident such an appeal will not be vain. LEONARD GREAVES.

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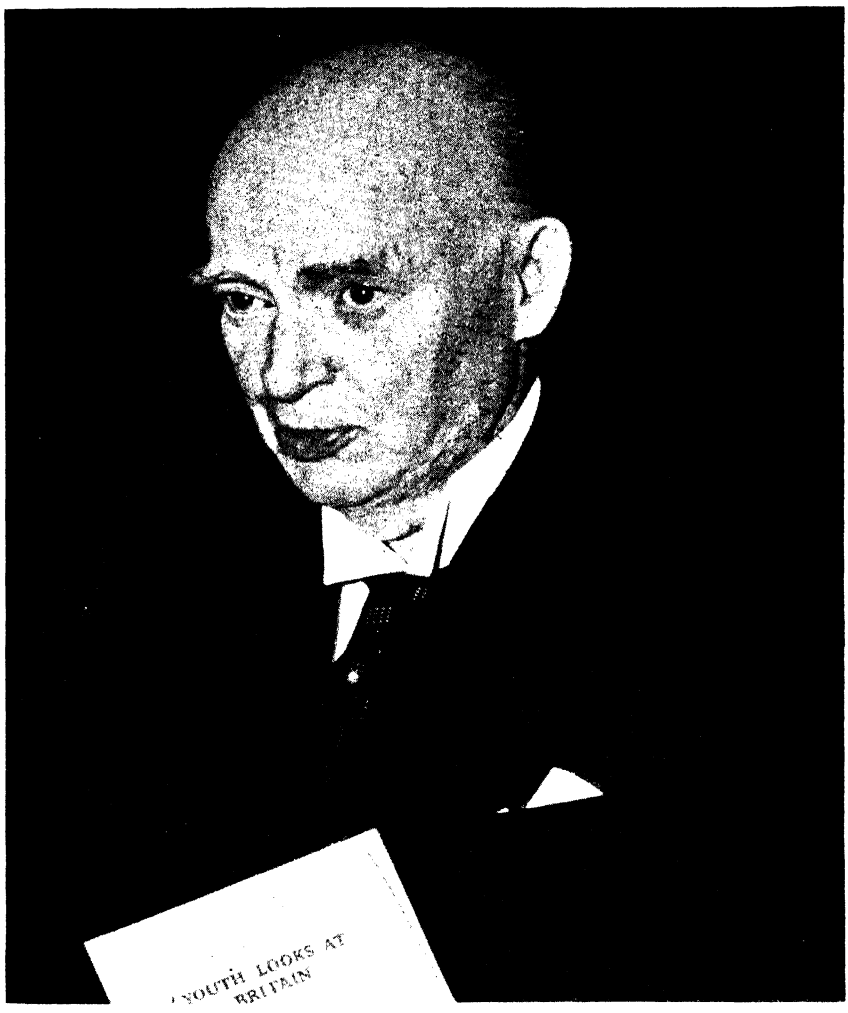
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JOURNAL OF THE ROYAL SOCIETY OF ARTS

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The Rt. Hon. Viscount BENNETT, P.C., K.C., LL.D., J.P., President of the Society, 1945-7, Chairman of the Council, January 21st, 1946—June 26th, 1947

OBITUARY

THE RIGHT HONOURABLE RICHARD BEDFORD, VISCOUNT BENNETT, P.C., K.C., LL.D., J.P.

The sudden death of Viscount Bennett which occurred on the 26th June came as a great shock to all who knew him, and was felt with special keenness by the Council and Fellows of the Royal Society of Arts. Only the day before he had been re-elected President of the Society and had presided at the Annual General Meeting with all his customary vigour and wisdom, coupled with those charming and subtle touches of humour which were so characteristic of him. Although he had been in failing health for some time he never allowed his interest in the Society to flag, and it seemed hardly credible that so vital a personality had passed away.

It is difficult to realise that he has left us, and the sense of personal loss, apart from the loss of his great services to the Society, is ever present with us.

He was a commanding figure, who inspired others with all that is best and never stinted himself in striving to achieve all he set out to do. R. B. Bennett, as he was then, joined the Society in 1940 and was elected a Vice-President and a Member of Council in 1941. So strong was his character and so great his intellect that he quickly made his presence felt and gave of his great knowledge and wide experience to the full. In 1945 he was unanimously elected President of the Society and in the following year, consequent on the death of Dr. E. F. Armstrong, he accepted the Chairmanship of the Council, although it meant much extra work and attention to detail in the conduct of the Society's affairs.

It would be difficult to over-estimate the great services he rendered in his dual capacity and, as in everything he undertook, he never spared himself, but fulfilled his duties at all times irrespective of ill-health or any obstacle. Without a doubt Bennett loved the Society deeply and nothing gave him greater pleasure and satisfaction than working for its welfare. He often used to recall how he came to join the Society. It appears that when he was in Canada he had the opportunity of seeing copies of the *Journal* regularly through a friend who was a Fellow, and he was so impressed by the great work the Society was doing and had done that he gladly accepted an invitation to join it when he came to live in England.

The paper which he read on "Empire Relations" will long be remembered and quoted as a most remarkable exposition of its kind.

Of Bennett the statesman and politician, and the great and intensely ardent upholder of Empire, much has been written and all who run may read. It is Bennett the man that we think of in connection with the Society. Always approachable, ready and willing to help and encourage at all times, a tower of strength and a mine of knowledge, he also radiated sympathy and friendship and although he might express strong views at times, he always did so in such a way that one realised here was a man who knew his subject and commanded admiration and respect. At the same time, he was always prepared to bow gracefully to the opinions of others if he was convinced that they were right.

Bennett's love of his native Canada and of the Commonwealth of Nations was almost a religion with him. Would there were more stalwarts of Empire such as he!

As a speaker Bennett was exceptional and the matter and manner of his speaking

were impeccable. His command of language and the fluency and ease of his utterances were remarkable and he could give an exposition on almost any subject without a note and in such a way as to hold the interest of his hearers throughout.

Truly R. B. Bennett was a great man in every sense and his name will live in history as one of the greatest Imperialists of our time. A fitting epitaph for him might well be in the words of Longfellow:

Lives of great men all remind us
We can make our lives sublime,
And, departing, leave behind us
Footprints in the sands of time.

[The Society was represented at the funeral service at Mickleham Church on Monday, June 30th, and also at the memorial service in Westminster Abbey on Friday, July 4th, which was attended by many members of the Council and Fellows.

The portrait of Lord Bennett on page 559 is reproduced from a photograph taken on Monday, June 23rd, at the opening of the exhibition of posters entered for the "Youth Looks at Britain" Competition, which was organised by the Royal Society of Arts in conjunction with the British Travel Association and the National Association of Girls' and Mixed Clubs. Another portrait of Lord Bennett, taken at the presentation of the Albert Medal last November, will be found on page 3 of this volume of the *Journal*.]

LIST OF FELLOWS

A new edition of the list of Fellows, corrected to January, 1947, is now available, and copies will be sent free to Fellows on application to the Secretary.

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Volume XCIV ended with the issue of November 8th, 1946.

THE VALUE OF GEOLOGICAL SURVEY WORK IN INDIA'S ECONOMIC DEVELOPMENT

By Sir LEWIS L. FERMOR, O.B.E., D.SC., A.R.S.M., M.INST.M.M., F.R.S.
formerly Director, Geological Survey of India

SIR GEORGE BIRDWOOD MEMORIAL LECTURE

India and Burma Section, Thursday, February 20th, 1947

Sir EDWIN PASCOE, M.A., SC.D., D.SC., *in the Chair*

THE CHAIRMAN: I need not remind you that this lecture is one of a series in honour of Sir George Birdwood, who was deeply interested in Indian art.

You may perhaps ask what a lecture on geological matters has to do with art, but I submit it has everything to do with it. You cannot have art without science. One of the first things that the old Italian painters had to do was to go out and pick up their paint; they had to collect ochres and various colouring materials before they could paint their pictures. Therefore I think a geological lecture in memory of a man who was a great art-lover is not out of place. The lecturer, my friend and erstwhile colleague, is known to most of you and needs no formal introduction. I would merely remind you, that he

was Director of the Geological Survey of India for six years, during which he was mainly responsible for the foundation of the Indian Academy of Science; that he is one of the world's best-known authorities on the subject of manganese; and that he has had first-hand experience in all aspects of the subject of his lecture. Without further preamble therefore I will ask Sir Lewis Fermor to read his paper entitled, "The Value of Geological Survey Work in India's Economic Development".

Sir LEWIS FERMOR then read the following paper:

I.—INTRODUCTION

The title of this lecture as announced might be otherwise expressed as "The Relationship of Geological Survey Work to Economic Development, as illustrated by India".

Before we can discuss the special subject of this address we must first suggest what is meant by economic development. There are sylvan economies and rural economies, for example, in which life is simple, and which may be complete in themselves: economic systems that have already developed fully within the circumscribed limits of their geographical situation: economic systems that it may be a sin to upset by the introduction of modern civilisation. But it is not such systems that are suggested by the title of this lecture. Instead, the phrase "economic development" carries with it, to most people, the connotation of development in accordance with modern civilisation, especially civilisation dependent upon or amplified by modern industrial developments. Indeed, when we talk of economic development we are in our minds turning away from the contemplation of simple rural scenes.

The economic development of any country as thus understood depends upon many factors, of which we may enumerate the following as the most important:

1. The existence of natural resources, such as minerals—using this term in its widest significance to include rocks, soils and water supplies—and forests with their contained timber and other vegetable products.

2. The climate, whether characterised by abundant or adequate rainfall, or of a desert type with insufficient rainfall.

3. The human factor—whether a country is densely or sparsely populated and whether the population is industrious, and able and willing to be trained in the complexities of modern civilisation.

4. The geographical position of the country with reference to trade routes and to overseas sources of raw materials, where these are insufficient, and to overseas markets in which surplus products may be disposed of.

Let us consider briefly each of these four factors, noticing the natural resources last.

Climatic.—India possesses the climates, or variations of climate, characteristic of a large sub-continental tract, for it is 2,000 miles long from its most northern point in Kashmir, lying in the temperate zone in 36° North Latitude, to its southern extremity at Cape Comorin only 6° north of the Equator; it is 2,200 miles wide from the Baluch-Persian frontier on the west to the Assam-China frontier on the east, spanning 36° of longitude, equivalent to 2 hours 24 minutes difference of time; it has an area of 1,576,000 square miles, and differences of height of over 29,000 feet from the Himalaya to sea level. The climates of this sub-continental tract may be summarised as ranging from alpine and temperate to tropical and

desert, with variations of rainfall from some 400 inches annually in Assam and the Western Ghats through all intermediate grades of rainfall to desert conditions in Baluchistan and Rajputana.

Human.—The human factor is stupendous, for in this sub-continent live some 400 million people (388,000,000, according to the 1941 census) in all stages of development from the most primitive to the most highly civilised. The majority of these peoples are willing workers and with their arts and crafts practised through the ages they have displayed their capacity to absorb and benefit from the developments of modern civilisation, however technical and complicated. In addition, their scientists have proved themselves fully competent to plunge into the vortex of modern scientific research and technological advance.

Geographical.—India occupies one of the world's strategic positions, cut off, with Ceylon and Burma, from the remainder of Asia by the fringing mountains of Baluchistan and the North-West Frontier on the west, of the Himalaya to the north, and of Assam and Burma on the east; but projecting southwards as a peninsula into the northern end of the Indian Ocean, which it thus dominates and to which it justly gives its name. In this position India lies on the trade routes from Europe through the Red Sea to the Far East, as well as providing the highway for air traffic between Europe and the Far East and Australia.

Natural Resources.—With India so richly endowed in respect of the second, third, and fourth factors enumerated earlier, namely, climatic, human and geographical, we may now enquire whether the natural resources of the country are ample enough to make possible the full use of these three factors.

In respect of forests India is amply endowed, for the high rainfall acting in conjunction with the warm climate of the summer has stimulated the growth of valuable timber in many parts of the country, the species varying with the climate and geology. Much of this forest has been preserved, however, only by the activities of the Indian Forest Department in reserving wide tracts against the continuous encroachments of the rapidly growing population, as a priceless asset for the continued use of the whole of this very population.

The geological conformation of the Indian sub-continent, with the high mountain ranges of the Himalaya in the north, looking down upon the Indian Peninsula, and subjected to constant denudation caused by frost, heat and rain, has provided, through the great rivers of Northern India and their tributaries, the fertile Indo-Gangetic Alluvium, which gives rich support to the agricultural activities of a large proportion of India's teeming millions.

But India's rainfall is seasonal, and over much of the country is confined mainly to the south-west monsoon, lasting some three to four months only, so that after a period of flooded rivers the surplus water drains away to the sea and is lost to agriculture, unless measures are taken to conserve it by storage. Many irrigation schemes have in consequence been carried out in various parts of India to store and distribute this rainfall, *e.g.*, in the Punjab and the Madras Presidency, with the result that India leads the world in the size, value and remunerativeness of its irrigation projects.

These abundant supplies of seasonal water provide opportunities not only for grand irrigation schemes, but also for the development of hydro-electric energy, in

some cases as ancillary to irrigation projects, but more often as the primary objective, with irrigation as a by-product using tail-waters. The great firm of Tatas has already developed several such projects in the Western Ghats, collecting monsoon rainfall in reservoirs above the Ghats for regulated discharge throughout the year to hydro-electric power stations located on the low coastal tracts below the Ghats. Similar schemes have been completed further south, in Mysore and Travancore, utilising the same combination of high rainfall and steep fall of land to the west. Many other schemes are now under consideration, and a beginning has been made in the development of hydro-electric projects in the Himalaya, where the possibilities are immense. Although gradients in the Himalaya are higher than for most Peninsular schemes, necessitating higher storage dams for the same storage capacity, yet Himalayan schemes have the advantage that water stored by dams is reinforced during the summer months by supplies derived from Nature's storage reservoirs of water frozen in snowfields and glaciers, the *houille blanche* or "white coal" of the French. As the discharged water from all these power schemes, Peninsular or Himalayan, can often be used for irrigation purposes, the development of hydro-electric power projects renders possible still greater additions to India's irrigated agricultural land.

Logically this Introduction should also contain some discussion of the mineral resources of India, as this term is commonly understood. But as such resources are the object of study by the Geological Survey of India it seems appropriate, in view of the title of this lecture, that they should be discussed in a separate section. Before doing this it is, nevertheless, desirable to devote a few lines to the scope of geology in respect of natural resources and to show that in the preceding paragraphs we have already been discussing a portion of the mineral resources of India.

Geology is concerned with the study of the earth, both as a whole and in detail; and in its widest sense this term covers the study of the atmosphere and the waters of the earth, as well as of the lands that lie beneath them. Consequently the constituents of the atmosphere, the waters of the earth, the rocks, minerals and ores, and the soils of the earth, in so far as they are of use to man, must all be regarded as included in the phrase "mineral resources" when used in its widest sense.

The study, however, of the day-to-day aspects of the atmosphere, that is, of present-day climate, has been resigned to meteorologists; but the logical position is perhaps indicated by the happy accident that the first Meteorological Reporter to the Government of India was an ex-officer of the Geological Survey of India, namely Dr. H. F. Blanford. And in spite of this separation of functions, geologists continue to be interested in the behaviour of the elements of climate, sunshine and cloud, snow, rainfall and drought, and their effects upon the land. Moreover, geologists continue to be the interpreters of the climates of the past, through their observations of the effects of these past climates on the rocks of the past and the nature of their entombed fossil contents, which fall by common consent within the sphere of study of geologists.

Water itself is an essential mineral, *the* essential mineral, and although its fall is recorded by meteorologists, its behaviour is controlled by irrigation engineers, and it is used beneficially by cultivators, by manufacturers, and by the whole of the

remainder of mankind, this diversity of study, control and use must not be allowed to obscure the fact that water is a mineral and that its occurrence above, on, and in the earth are essentially matters for geological study, so that in many countries it is in the location of this essential of life that geology finds its greatest application.

II.—The Mineral Resources of India

In the Introduction I have indicated that amongst the mineral resources of India must be included its water supplies, both surface and underground, including the *houille blanche* or white coal of the Himalaya, both for use as such, and for the generation of electric energy.

But when one speaks of mineral resources one is usually understood to mean the mineral products that are extracted from the ground for the use of man, either from surface quarries or from underground mines. It is such products that are recorded in the mineral production statistics of a country; they include metallic ores, non-metallic minerals such as fuels (coal and oil) and refractory materials, and materials used for building and other constructional purposes, such as building stones, cement materials, sands and clay. Such recorded statistics are of use in two ways. First, they indicate the state of industrial development to which a country has risen; especially by the extent to which the mineral products are used in the country, or, if exported, are exported in the raw, the semi-finished, or the finished condition. Second, their nature and variety suggest the type of mineral terrain that prevails, giving hints, perhaps, of the possible existence of minerals of which the production or discovery has not yet been recorded.

In my paper "India's Mineral Resources and the War"[1] I gave tables of the quantity and value of the mineral production of India (excluding Burma) from 1934 to 1938. Through the kindness of Dr. W. D. West, the present Director of the Geological Survey of India, I am able now to present, in Tables 1 and 2, the mineral production figures of India for the quinquennial period 1939 to 1943, and also for 1944. For ease of comparison with the figures for 1934 to 1938 I have kept the items in the same order as in the paper cited, which is the order of value for 1938. The only data missing from these new tables are for the minor items previously grouped under "other minerals", which are not likely to have been substantially higher than before (less than 1 per cent. of the total value). In the third table I show the output of metallurgical products for the same period.

From a comparison of the means of output, either by quantity or by value, for the three quinquennial periods 1914–18, 1934–38 and 1939–43, as shown in these tables, the great growth of India's mineral production over a period of some thirty years can be seen. And although some of these minerals are necessarily exported in the raw condition, at least in part, *e.g.*, manganese ore, mica, ilmenite, chromite and kyanite, yet industries have developed in India to an extent sufficient to use in the country its coal, petroleum, iron ore, copper ore, and bauxite, the resultant metal production of iron and steel and of copper finding expression in Table 3. The gamut of minerals, of which the production is shown in Tables 1 and 2, is mainly that characteristic of Peninsular India, or, as geologists will recognise, of Gondwanaland. The sulphide minerals, such as the ores of lead, zinc, silver and

[1] *Asiatic Review*, XXXVI, pp. 733–44 (1940).

TABLE 1.—QUANTITY OF THE MINERAL PRODUCTION OF INDIA, 1939 TO 1944

	Mean 1914–18	*Mean 1934–38*	1939	1940	1941	1942	1943	*Mean 1939–43*	1944
Coal (tons)	*17,951,583*	*24,212,851*	27,769,112	29,388,494	29,463,742	29,443,253	25,511,909	*28,313,302*	26,126,676
Manganese ore (tons) ...	*577,457*	*776,151*	844,663	869,704	791,141	757,269	595,366	*771,628*	370,980
Gold (oz.)	*584,556*	*326,250*	314,515	289,324	285,930	260,302	252,228	*280,460*	188,206
Petroleum (gals.)	*7,325,376*	*74,114,061*	81,459,571	96,688,799	101,451,155	97,735,868	95,718,986	*94,610,876*	97,453,077
Mica (cwt.)(*a*)	*49,586*	*176,970*	198,368	170,323	208,331	170,678	201,615	*189,863*	72,238
Salt (tons)	*1,356,043*	*1,508,127*	1,498,988	1,645,531	1,778,978	1,891,960	1,926,892	*1,748,470*	1,864,725
Iron ore (tons)	*408,643*	*2,479,914*	3,166,074	3,103,356	3,195,057	3,218,796	2,655,197	*3,067,696*	2,363,615
Copper ore (tons)	*8,054*	*339,251*	360,624	401,293	381,449	363,166	359,789	*373,264*	326,018
Ilmenite (tons)	—	*155,288*	237,835	263,152	129,040	49,188	37,789	*143,401*	100,794
Saltpetre (tons)(*b*)	*20,949*	*8,183*	8,560	10,101	10,486	5,118	2,321	*7,317*	2,118
Kyanite, etc. (tons) ...	—	*40,094*	33,718	23,443	32,272	27,191	32,425	*29,810*	29,186
Chromite (tons)	*22,929*	*43,329*	49,136	55,511	50,135	49,585	33,255	*47,524*	39,555
Magnesite (tons)	*10,165*	*19,841*	33,568	43,297	40,710	47,780	49,070	*42,885*	41,936
Zircon (tons)	—	*2,405*	721	3,137	2,502	273	—	*1,327*	755
Bauxite (tons)	*939*	*8,249*	8,977	8,025	12,962	18,258	24,160	*14,476*	12,135
Tungsten ore (tons) ...	*28.5*	*4.6*	—	40	70	79	77·5	*53*	30
Beryl (tons)	—	*67*	389	52	—	119	1,463	*405*	500
Corundum (tons)	*24,534*	6.4	0.75	0.02	55	133	108	*39*	343
Tantalite (cwt.)	—	*5.8*	—	—	—	—	71	*14*	9
Building materials (tons) ...	*1,661,699*	*7,451,148*	10,608,494	8,472,979	9,608,106	11,878,431	10,891,724	*10,291,947*	13,637,826

(*a*) Exports. (*b*) Exports plus consumption in tea gardens.

TABLE 2.—VALUE OF THE MINERAL PRODUCTION OF INDIA, 1939 TO 1944.

	Mean 1914–18	*Mean* 1934–38	1939	1940	1941	1942	1943	*Mean* 1939–43	1944
	£	£	£	£	£	£	£	£	£
Coal	*4,419,174*	*5,631,763*	7,404,294	7,887,392	8,073,226	9,817,880	12,713,050	*9,179,168*	20,429,410
Manganese ore(*a*)	*1,255,330*	*1,688,658*	1,360,779	1,481,848	1,377,854	1,343,564	1,032,458	*1,321,100*	644,335
Gold	*2,250,787*	*2,265,208*	2,432,577	2,434,580	2,484,884	2,826,258	3,813,395	*2,798,339*	2,512,623
Petroleum	*28,098*	*1,000,215*	1,222,199	1,419,462	1,508,609	1,436,692	1,366,820	*1,390,756*	1,338,153
Mica(*b*)	*383,015*	*734,475*	1,153,656	1,203,652	1,992,061	1,924,055	2,336,653	*1,722,015*	2,047,609
Salt	*785,740*	*650,164*	626,963	723,278	796,682	931,043	1,244,356	*864,464*	1,846,478
Iron ore	*34,108*	*291,057*	391,545	399,845	416,700	449,382	412,111	*413,917*	420,434
Copper ore	*11,806*	*285,930*	359,200	443,897	444,314	429,481	463,537	*428,086*	504,584
Ilmenite	—	*72,109*	112,190	123,579	54,051	25,090	16,033	*66,189*	55,448
Saltpetre	*474,199*	*91,710*	106,026	181,068	190,238	111,984	69,590	*131,781*	—
Kyanite, etc.	—	*36,494*	19,950	17,995	23,733	26,983	33,335	*24,399*	33,497
Chromite	*20,164*	*43,722*	47,663	55,727	67,649	70,490	48,506	*58,007*	52,986
Magnesite	*7,568*	*9,459*	15,881	20,789	20,299	24,271	41,369	*24,522*	39,358
Zircon	—	*4,061*	1,941	10,333	6,808	615	—	*3,939*	2,095
Bauxite	*408*	*1,652*	1,277	1,024	1,757	3,141	8,181	*3,076*	4,283
Tungsten ore	*4,949*	*512*	—	2,250	3,750	13,378	27,311	*9,338*	6,750
Beryl	—	*299*	67	(*c*)	—	(*c*)	3,417	*697*	3,355
Corundum	*2,301*	*103*	6	2	838	1,898	1,413	*831*	5,851
Tantalite	—	*20*	—	—	—	—	(*c*)	—	(*c*)
Building materials ...	*121,005*	*720,593*	784,295	720,963	822,028	1,167,427	1,992,761	*1,097,495*	1,688,990
Other minerals	*61,533*	*81,640*	—	—	—	—	—	—	—
	£9,860,185	£13,609,844	£16,049,509	£17,127,684	£18,285,481	£20,603,632	£25,624,296	£19,538,119	£31,636,239

(*a*) Value f.o.b. (*b*) Exports. (*c*) Value not recorded.

TABLE 3.—PRODUCTION AND VALUE OF METALLURGICAL PRODUCTS IN INDIA, 1939 TO 1943.

	Mean 1914–18	*Mean* 1934–38	1939	1940	1941	1942	1943	*Mean* 1939–43	1944
	Tons	*Tons*	Tons	Tons	Tons	Tons	Tons	*Tons*	Tons
Total pig-iron produced ...	*243,353*	*1,494,655*	1,757,041	1,994,234	2,009,865	1,829,741	1,748,872	*1,867,951*	1,430,749
Pig-iron exported	—	*519,850*	556,602	627,099	581,591	244,684	204,579	*442,911*	180,521
Pig-iron not exported	—	*974,805*	1,200,114	1,369,128	1,428,274	1,585,057	1,544,293	*1,425,373*	1,250,228
Pig-iron converted to steel ...	—	—	893,383	1,094,357	1,171,120	1,087,593	1,152,031	*1,079,697*	1,090,905
Steel produced	*95,986*	*648,702*	741,717	933,794	1,042,177	988,442	1,003,599	*941,946*	1,002,908
Ferro-Manganese	*4,069*	*9,881*	1,613	18,199	30,563	20,525	6,236	*15,427*	5,079
Copper, refined	—	*6,512*	6,535	6,650	6,019	5,874	6,100	*6,236*	5,730
Values of some of above production:	£	£	£	£	£	£	£	£	£
Pig-iron exports	—	*1,204,498*	2,088,216	2,386,135	2,251,518	927,657	814,125	*1,693,530*	687,241
Pig-iron not converted to steel, excluding exports (*a*)...	—	(*d*) *592,139*	—	—	—	—	—	—	—
Steel(*b*)	—	(*d*) *5,093,898*	7,417,170	9,337,940	10,421,770	9,884,420	10,035,990	*9,419,458*	10,029,080
Ferro-Manganese(*c*)	—	(*d*) *132,130*	—	—	—	—	—	—	—
Copper	—	(*d*) *396,136*	—	—	—	—	—	—	—

(*a*) Valued at export values. (*b*) Valued at £7 10*s*. a ton for 1934–38; thereafter at £10 a ton. (*c*) Valued at £10 a ton.
(*d*) Mean of 1937 and 1938.

antimony, are all missing, with the exception of copper, having been lost with the separation of Burma.

III.—The Geological Survey of India

On account of the importance of a knowledge of its mineral resources, every civilised country maintains an organisation charged with the duty of making systematic geological surveys as the basis of the understanding of all mineral problems, including under this head the mode of occurrence and value of its useful minerals; the distribution of its water supplies, especially those that lie underground; the multitude of engineering problems, the correct solution of which depends upon a knowledge of the disposition of the rocks and of their properties; such problems as sites for dams and reservoirs; alignments of railways and roads and the materials for their construction; and, in countries like India, the understanding of the causes of earthquakes and landslips, and the methods of mitigating their dire effects.

During the first half of the nineteenth century the East India Company employed at intervals individual geologists, such as Voysey, Williams and McClelland; but it was not until the arrival in India in 1851 of Dr. Thomas Oldham that the Geological Survey of India as a regular department was formed. From that date the Department has been in continuous operation and has laid the foundations of our knowledge of the stratigraphy of India and of its mineral deposits.

Throughout the nineteenth century the staff of the Department was small, absurdly small in comparison with the size of India, but this small staff achieved magnificent results. However, from the appointment in 1903 of Sir Thomas Holland as Director of the Geological Survey of India, the sanctioned staff was raised in successive steps to thirty-six by the time of the economic blizzard of 1931 to 1932. As with all other scientific departments of the Government of India, the Geological Survey was then severely pruned, owing to the Government's inability to realise that the last activities to curtail on account of economic stress should be those of its scientific services.

A few posts in the Geological Survey were gradually retrieved by the time of the outbreak of the recent war, raising the strength to twenty-nine; and now that the war is finished and India wishes to take a great step forward, economically and industrially, in the world, the help that can be obtained from geologists has at last been realised. The plea that the Budget would not permit the expenditure necessary for scientific work on an adequate scale has been abandoned, and India is now prepared to spend lavishly on all branches of scientific and technical research in the belief that such expenditure will ultimately justify itself by results and lead to the economic and industrial uplift of the country. Five technical research institutes have been sanctioned and the foundation stones of all have been laid or are in process of being laid. These are, respectively, the Glass Research Institute in Calcutta, the Fuel Research Institute at Dhanbad, the National Metallurgical Laboratory at Jamshedpur, the National Physical Laboratory at Delhi, and the National Chemical Laboratory at Poona. Since all these research institutes are for the promotion of industries based on mineral products, it is not surprising that at last the value of geological survey work is understood.

I have recently received from Dr. West, the present Director, a brochure entitled *A Five-Year Plan for the Geological Survey of India*, described as a memorandum on the expansion and reorganisation of that department, and published by the order of the Government of India, dated Calcutta, December, 1946.

As already mentioned, at the outbreak of war the sanctioned strength of the Department was twenty-nine. This has now been increased by eighty-two, of whom forty-three have already been recruited, partly on a permanent and partly on a temporary basis. The ultimate target is a total strength of 141, composed of a Director, a states liaison officer, ten superintending geologists, thirty-four geologists, eighty assistant geologists, two geophysicists, one petroleum geologist, two mining engineers and ten chemists. In view of the past this is a tremendous objective. The small number of senior geologists still left in the Department have before them indeed a tremendous task in training in the field such a great number of young geologists. These men will be recruited mainly from the Indian universities, but an attempt is being made to recruit some experienced geologists from abroad, on a contract basis, to help with this expansion. To train the young geologists the plan is to organise field training camps under the senior geologists; in addition, some of the men are being sent abroad, both to Britain and Australia, to amplify their Indian training. A batch of ten has recently returned from Melbourne University, where a special course was arranged for their needs. All geologists will watch with interest this experiment in rapid expansion, and hope for its success, as thereby an impetus will be imparted to industry and to the general welfare of India.

In the past the fundamental task of the Geological Survey of India has always been, as it must be of any sound geological survey department, the systematic mapping of the country. Much of India has been thus surveyed, but the small staff compared with the size of the country (staff always less than that of the United Kingdom, for example) has prevented the completion of the geological map of India even on a broad scale. Some parts of the country are still unsurveyed geologically. On the other hand, much of the country has been completed on the scale of 1 in. to the mile, and in some of the coalfields the work has been done on the scale of 4 in. to the mile. Even when the enlarged staff has been secured and trained, many years of systematic work connected with mapping on various scales will still lie ahead, and the energies of a large proportion of the staff must continue to be directed to this task.

Throughout its long history not only has the Geological Survey of India made maps, but it has also kept in view economic problems, though the tempo and emphasis have varied. The Department was in fact originally formed, at least in part, for the survey of the coalfields. Throughout the nineteenth century coal was the main economic preoccupation of the Department, but attention was also given to other minerals, such as gold, iron ores, mica and petroleum. It is of interest to record here a fact that is often overlooked, that Thomas Oldham himself first discovered (in Burma) the principle of the accumulation of mineral oil in anticlines, the principle that guides the whole of the world's great modern oil industry in its search for petroleum.

The twentieth century has seen an increase in the economic bias of the Department, a bias that has found expression in the publication of special memoirs on

particular minerals, *e.g.*, on mica, manganese ore deposits, petroleum and coal. The diamond drilling undertaken by the Department on the then abandoned copper belt at Singhbhum has led to the establishment of the modern copper industry, as represented by the Indian Copper Corporation, which is responsible for the entire production of copper recorded in Table 3. The modern iron and steel industry of India (see again Table 3 for output) has also been developed in part as the result of discoveries and help given by the Geological Survey of India, as has also the chromite industry of Singhbhum. The bauxite deposits of India were originally discovered by the Geological Survey, and at long last we have a successful aluminium smelting industry in India.

On the engineering side the Department has for many years given help throughout India, *e.g.*, on the foundations of dams and the suitability of reservoir sites, on railway and road alignments, in landslip and earthquake research, in road-metal and building-stone supplies, and in supplies of fluxes for smelting and of limestone for fluxing and for cement manufacture, one of the major modern industries of India.

During both wars the Department has helped with the provision of minerals needed for war purposes. In the earlier war the Department took vigorous steps to spur on the output of wolfram in Tavoy and Mergui in Burma and to increase the mica output in Bihar, a part of this industry being then controlled departmentally. In the late war a Utilisation Branch was formed and attention was given, amongst other problems, to the working of the sulphur deposits of Baluchistan and to the development of a lead-zinc mine at Zawar in Rajputana, mining engineers escaped from Burma on the Japanese occupation being temporarily added to the staff of the Geological Survey of India.

The Geological Survey of India has always been financed by the Government of India, but its operations have not been confined to British India, the Indian States having been treated as within the ambit of the Department. Some of the Indian States, *e.g.*, Mysore, Travancore, Hyderabad and Kashmir, have formed their own geological or mineral departments and have built on the foundations laid by the Geological Survey of India, thus ensuring for themselves more intense study than they could expect as their share of the attentions of the exiguous staff of the Geological Survey of India.

In view of this account of the past achievements of the Geological Survey of India it may be asked what increased benefits are expected to flow from the increase of staff now being provided. There will, of course, be the increase in the rate of mapping already alluded to, and the possibility of a more intensive study of the known mineral fields of India, and of new discoveries, as well as the study of minerals that were formerly of no economic value but have become of interest owing to modern invention. In addition, it is now proposed to form a Mineral Development Section, to carry out drilling and exploratory mining, this section replacing the Utilisation Branch formed during the war. Dr. West lists some of the problems that are to be studied by the branch in the near future. The following may be enumerated:

(1) Physical and chemical survey of the coal seams in conjunction with the proposed Fuel Research Institute.

(2) Mapping and drilling of the iron ore deposits of Chanda and Drug.

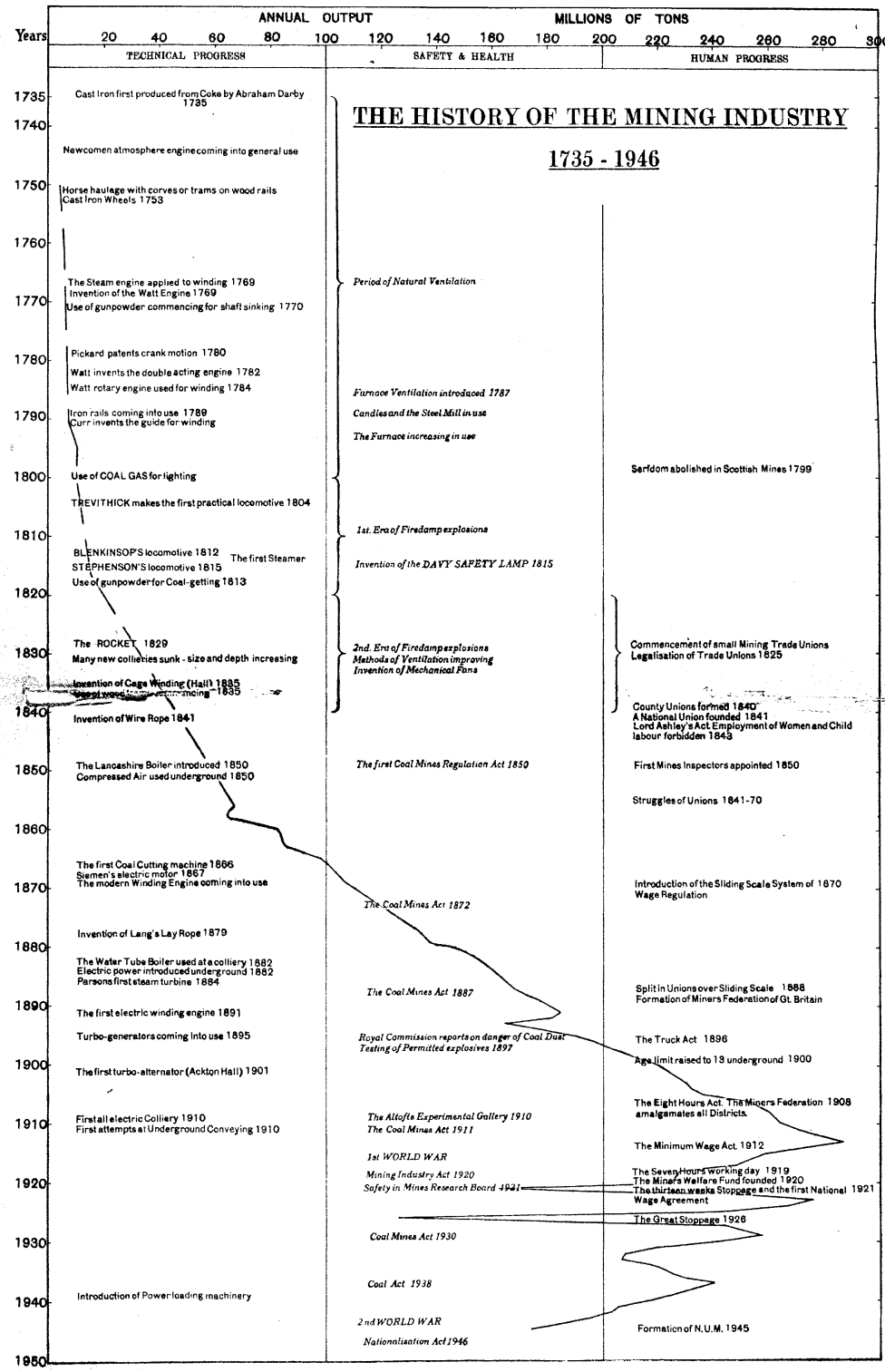


Fig. 1
British Coal Mining and the Industrial Revolution (see page 578)

(3) Re-examination of the manganese ore deposits outside the Central Provinces and examination of the possibility of beneficiating low-grade manganese ores.
(4) Reserves of magnesite.
(5) Detailed survey of bauxite deposits, already begun.
(6) Study of the raw materials needed for the ceramic and glass industries.
(7) Study of the minerals found in pegmatites—mica, beryl, tantalite, felspar, rock crystal, and possible uranium-bearing minerals.
(8) Survey of the beach sands of Orissa and of the Madras Presidency for thorium-bearing minerals (monazite, etc.).

An Engineering Geology and Ground Water Section has been formed as a separate unit in 1945. It is divided into two branches, as the name suggests. The work of the Engineering Geology Branch promises to become of the greatest use, and its expansion will depend to a large extent on the relations to be maintained with the Central Technical Power Board and the Central Waterways, Irrigation and Navigating Commission. In order to force or jerk forward the industrial and agricultural development of India, so as to cope with the needs of the rapidly-growing population, planners in that country have decided that the first priority must go to hydro-electric development, utilising the power possibilities of the Himalaya and the Peninsula, and developing river basins such as the Damodar Valley with its coalfields, industrial establishments and agricultural possibilities, along lines similar to those adopted by the Tennessee Valley Authority. Not only is electricity required for industrial power purposes in parts of India remote from the coalfields, but there are visions of an ultimate all-India electric grid, with electric light for villages throughout the country. These may be visions, but their realisation may be made possible if all Nature's power resources are harnessed. Upon the Geological Survey, therefore, much work and responsibility will be thrown in the vetting of sites for dams, reservoirs and tunnels, and officers have already been detailed for work on the following major projects: Teesta, Kosi, Mahanadi, Damodar and Mor, Nayar, and Bhakra, as well as minor dams in other parts of India. The superintending geologist in charge of this Section has shown a special flair for such work and has visited the U.S.A. to study methods in use there.

The Ground Water Branch is starting with only three officers against the eight already allotted to the Engineering Geology Branch, but the ultimate objective is for one officer for each province, with a total strength of fifteen, of whom two will be attached to the Central Ground Water Section of the Government of India. In order that this branch of work shall be developed on sound lines, it is intended to send officers to the United States to study water problems with the Water Resources Branch of the U.S. Geological Survey.

A Geophysical Section has also been formed with a nucleus staff which is to be expanded as men and equipment become available. The geophysical problems to which the department will devote its main activities are the numerous small ones of dam foundations, river sand supplies, water supplies, and metalliferous and coal supplies, such problems as may be investigated quickly with results useful for the immediate development of the country, rather than the major tectonic studies that will yield results only after many years, studies that are perhaps more suitably left to the oil companies who will be the principal beneficiaries therefrom.

The Department has always been ready to answer enquiries on mineral subjects received from the general public. To aid this work still further, it has been decided to institute within the Geological Survey a Mineral Information Bureau in general charge of Mr. D. N. Wadia, a former officer of the Department, which, besides disseminating in non-technical language information relating to Indian minerals and fuels, and giving free advice on the uses and processing of raw minerals, will also help industrialists with assays and analyses, and with physical tests for beneficiation, etc. This section will also publish a new semi-popular journal called *Indian Minerals*. This will be, of course, in addition to the continued issue of the regular publications of the Department: the well-known *Memoirs* and *Records of the Geological Survey of India* and the *Palæontologia Indica*, all of which, one is glad to learn, are to be restored to their pre-war format.

At present the Geological Survey is housed in one of the buildings of the Indian Museum, Calcutta, in quarters that were barely adequate for the former maximum staff of thirty-six, after allowing for officers seconded to Burma. The expansion that has now begun throws this accommodation completely out of balance, and there is no room for expansion by additional building. This consideration, combined with the logic of circumstances, has caused the Government of India to decide to transfer the Headquarters of the Geological Survey as soon as possible to New Delhi, where it will be housed in a building specially designed for the purpose. The formal opening of such a new headquarters when completed would be a suitable means of celebrating the first centenary of the Department's existence due in 1951.

IV.—Power

The three fundamental necessities for the economic and industrial development of a country are men, materials and energy (often miscalled "power"). In the Introduction I have mentioned the manpower of India and its natural resources and have alluded to its power resources. It is appropriate that I should end on the question of power; for, leaving out man-power, the main source of mechanical power in India lies in the mineral world. India's power resources can be grouped under four heads:

(1) *Hydro-electric possibilities.*

(2) *Petroleum resources*, which, as at present known, are relatively small in comparison with India's consumption, and will remain so unless the long-term researches of oil companies by geophysical methods reveal the existence of major deep-seated supplies under such tracts as the Gangetic alluvium.

(3) *Coal resources*, which are adequate as a source of power, but inadequate, as compared with India's enormous iron ore deposits of the highest grade, in respect of supplies of coal suitable for the manufacture of metallurgical coke.

(4) *Atomic energy.*—The beach sands of the Travancore coast contain monazite as one of their valuable constituents, this coast being one of the world's principal treasuries of this mineral. But since the decline of the use of the Welsbach mantle, as a result of the widespread substitution of electricity for gas as an illuminant, the extraction of monazite from these sands has fallen off in favour of the associated ilmenite, now widely used in the manufacture of paint. But monazite contains thorium, one of the sources of atomic energy. When the technical problems have

been solved of directing the atomic energy of uranium and thorium to industrial power production, then India will find herself endowed with a valuable additional source of energy to set alongside her hydro-electric energy and her coal. Uranium-bearing minerals—pitchblende and samarskite—are also found in India, associated with the mica-bearing pegmatites, but their occurrence is sporadic, and the main source of atomic energy in India as at present known will be monazite won from the beach sands of Travancore and elsewhere, in Orissa and the Madras Presidency.

With the general and mineral problems involved in all these sources of supply of the energy so essential to the economic and industrial development of India it will be seen that the Geological Survey of India has before it great responsibilities and also great opportunities to help in this development.

DISCUSSION

THE CHAIRMAN: We have all listened with keen interest to what Sir Lewis Fermor has so ably said regarding geological activities in India. I am told that it is not usual to discuss a Memorial Lecture, but as there seems to be a little time available I think we might break that rule.

One hopes that the expansion of the Geological Survey of India will not mean the elimination of the private prospector and geologist. Invaluable work has been done in the past by the geological staffs of private companies, especially those concerned with oil, manganese, coal, silver, lead, zinc, tin and wolfram, and a discontinuance of such private efforts would be a scientific as well as an economic loss to India.

We should, for example, be without an extremely valuable and important paper on "Geological Factors in Gravity Interpretation" by Messrs. Evans and Crompton of the Burmah Oil Company, which was published only last week and is indeed an epoch-making contribution to the subject of Isostasy.

There is one aspect of future geological work in India which I would stress, and that is the importance of a close liaison with other scientific departments. Every now and then problems present themselves which concern more than one department, and for that reason are rather apt to be shelved. It is very important to keep in close touch with the Geographical Survey of India in order to preserve unanimity in the spelling of place-names. In India itself we have reached a high degree of conformity in this matter, but in the case of Burma much remains to be done. With its monosyllabic agglutinative language it presents many difficulties. In my attempts to write a third edition of the Geology of India and Burma I have been sadly hampered by the lack of consistency in the spelling of Burmese place-names.

There should also be the closest liaison with agriculturists. The subject of soils, for example, is one in which the geologist can, and very often does, give valuable advice. There are, however, some borderline subjects which seem to have eluded the active attention which they deserve, probably because they *are* borderline subjects. One of these is the burning of cow manure as domestic fuel in India. Eighteen years ago I drew attention to this industrial abuse and I should be interested to learn if any successful attempt has been made to remedy it. Dry cow-dung was then being sold in Indian bazars throughout the country as fuel at a price that was less than its value as a land fertilizer—in some Provinces for less than half its value.

A substitute for this animal product is obviously some of the twenty thousand million tons of coal which are estimated to be available within one thousand feet of the surface, or a soft coke produced therefrom. The greater part of these coal reserves is of inferior quality, but much of it is capable of yielding a soft coke suitable for a properly-designed Indian *chulha*. In any case, second-class Indian coal cannot be much worse than the third-class coal of which we are being compelled to make use during the present

emergency in this country! The coal expert says: "This is not my job but one for the agriculturist", whilst the agriculturist says: "I cannot induce the Indian farmer to forgo a fuel which he picks up for nothing on his farm, unless there is a substitute on the market cheaply acquired and easily manipulated."

The impoverishment of the land due to the ill-considered use of a valuable natural fertilizer must be enormous and widespread, and will continue until the Indian farmer is educated to the real value of what he is burning and is supplied with a more economic substitute.

Some seventeen to eighteen years ago it was estimated that among a population of over three hundred million people, barely two million tons of raw coal and soft coke were being used annually as domestic fuel. In 1929 an Act was passed levying a cess of two annas a ton on soft coke despatched from Bengal and Bihar and Orissa. This cess was to be used for promoting the sale and improving the manufacture of soft coke, but I cannot help feeling doubtful as to the result of such a measure. I should have thought that a cess would mean a rise in the retail price of coke, which would make it more expensive for the farmer and would therefore diminish its attraction as a competitor with a gratuitous fuel like dried cow manure. One would like to know to what extent this legislation was effective.

Mr. P. EVANS, M.A., F.G.S. (*Burmah Oil Company*): I have been extremely interested in all that Sir Lewis Fermor has had to say, but one point that came home very closely to me was his reference to Thomas Oldham. About a year ago I had the honour to speak in this room, and in referring to the history of petroleum in Burma I had wanted to say that one of the fundamental factors in the accumulation of oil had been first recognized in Burma. Although it has been stated that the relation of anticlines to oil was first discovered by Oldham, I was not able to satisfy myself from his own writing that Oldham did in fact make this discovery, but I hope that the lecturer has been more fortunate and has found references which show that Oldham did hit on the principle of the accumulation of mineral oil in anticlines.

I welcome the increase planned for the Geological Survey of India. Immediately before the war, the geological staff of one industrial concern operating in India and Burma was larger than the whole country's official geological staff, which seemed a lack of balance. I was very glad to see that this is being changed. For many years there have been most friendly relations between the Geological Survey of India and the geologists of the various oil and mining concerns. We have always been made most welcome when visiting the headquarters of the Geological Survey, and the individual officers of the Survey have been most helpful in providing information. When I was in India I came to regard the Survey offices as almost a second home. I think that these opportunities for discussion were a help to both sides, and I hope that the much-expanded Survey will continue to have close relationships, not only with industrial geologists working on economic problems, but also with academic geologists in various centres in India.

As one of the "consumers" of the products of the Geological Survey, I would say that the primary aim of the Survey should be the production of a geological map of the whole of India. I do not think that the Survey should be expected to do work which can be done by the economic geologists employed by industrial concerns. The Geological Survey should provide the geological background needed for the investigations of the economic geologists, and they should be able to look to the Geological Survey for general guidance and information, but should not expect to be spoon-fed. It seems reasonable for the geologist engaged on economic work to turn to the Geological Survey for the identification of minerals and fossils and for the provision of references, so that he can make sure that he is carrying out his own work in the most suitable way. This service may seem comparatively simple, but it does need a great deal of knowledge on the part of the geologists of the Geological Survey.

I agree with the lecturer that the geophysical work of the Survey should, at least for the present, be confined to what one might call short-term projects, and I would stress particularly the great importance to India of the application of geophysical methods of

water-finding. Geophysics has been more successful in the search for oil than in the search for water, and this may be because it has not been anybody's business to encourage the application of geophysics to water-prospecting. The lecturer has reminded us of the importance of water to India, and it does seem possible that the search for water is a field in which geophysical work has a chance of being particularly useful. I hope that this possibility will be investigated and that the geophysical branch will be successful in increasing the water resources of an area which is so greatly in need of additional supplies.

In conclusion, I would say again how much I, for one, have enjoyed listening to Sir Lewis Fermor giving this account of the Geological Survey of India.

Mr. C. BURNS: It was with great interest that I listened to Sir Edwin Pascoe's reference to the great problem concerning the use of cow dung as manure in India instead of more usual fuels, because a previous India and Burma Section meeting dealt at some length with that very problem. Sir Herbert Howard wound up his address on that occasion by explaining how the Forestry Department of India proposed to double the area of forests in India which could be utilised for local fuel purposes, and in that way attack the problem of which the economists and agriculturists have washed their hands. They are accordingly planning an increase in staff parallel to the increase in the establishment of the Geological Department of which Sir Lewis Fermor has told us.

THE LECTURER: The question which the Chairman has raised concerning the use of animal manure in India has already partially been answered by Mr. Burns, that is to say, its use as fuel is to be decreased in the future. Personally I have not taken an interest in this problem, but I am aware of the fact that the Government of India is taking steps to erect a large works to manufacture artificial fertilisers, namely ammonium sulphate, in quantity, for helping agriculture in India.

With regard to the point raised by Mr. Evans, I do not know where I discovered the statement regarding the accumulation of mineral oil in anticlines. It is something I have known for years, so to speak, and I do not know where to find it. Perhaps it can be left as a challenge to somebody to say it is not true.

THE CHAIRMAN: I now have very much pleasure in proposing a hearty vote of thanks to Sir Lewis Fermor for his very able and interesting lecture.

The motion was carried with acclamation.

Sir KENNETH MITCHELL: Before we break up, I have much pleasure in proposing a vote of thanks to Sir Edwin Pascoe for having taken the chair to-day. At the same time I should like to confirm what the lecturer has told us regarding the substitution of artificial fertilizer for the burning of dried cow dung.

The vote of thanks was carried with acclamation and the proceedings then terminated.

BRITISH COAL MINING AND THE INDUSTRIAL REVOLUTION: WITH SPECIAL REFERENCE TO THE LIFE AND WORK OF THE LATE LORD CADMAN

By Professor DOUGLAS HAY, M.C., B.SC., M.I.C.E.,

Chief Mining Engineer, National Coal Board

CADMAN MEMORIAL LECTURE

Seventeenth Ordinary Meeting, Wednesday, March 19th, 1947

The Right Hon. LORD HYNDLEY, G.B.E., *Chairman of the National Coal Board, in the Chair*

THE CHAIRMAN: It gives me much pleasure to preside this afternoon for two reasons in particular. First, the lecturer is a very distinguished person and the much respected

Chief Mining Engineer of the National Coal Board and, second, the lecture is described as having special reference to the late Lord Cadman. I knew Lord Cadman very well and held him in the greatest possible affection and regard. He was a great man and he spent his life doing great work for this country. I had the pleasure of working with him for several years in the old Mines Department when we were both advisers on different subjects and I shall always remember him with great affection. I will say no more now, but call on Professor Hay to address you.

Professor HAY then delivered the following lecture:

Whatever may be the result of our modern ideas of social progress, in which we look to the community to solve its problems by its mass endeavour, it is none the less a fact that the chief milestones on the road of human progress mark the lives of great individuals. Such men possess an inner light, which enables them to see clearly the path man should follow, in a way not given to the common man, and certainly not to the mass intelligence, which may be swayed by catchwords, phrases and urges of the moment, often quite unrelated to the true path of salvation: and such men are more often than not deeply religious.

Such a man was John Cadman, Baron Cadman of Silverdale, whose name will always be remembered in the mining industry of this country. His life's work covered a vast field of human endeavour.

I knew him for thirty years, and, on a personal note, I remember the great charm of his personality, his breadth of vision and his enterprise. He was, indeed, a leader of men, attracting men's loyalty, that virtue so rarely appreciated at its true worth. His life was laid in a period of great change. Rapid though the development of the Industrial Revolution had been, in his lifetime a development was taking place in the heart of man; a new social outlook was appearing. And Lord Cadman was one of those leaders who, by his awareness and humanity, was well fitted to be a leader in his period. To bring his life into true relief I must sketch for you briefly the background of those times—the Industrial Revolution as we call it.

In discussing the Industrial Revolution it is profitable first to enquire what we understand by the term itself. To do this we must look back over the centuries.

The fourteenth century drew the curtain on a new era—the England of Chaucer, the slow passing of the Middle Ages and the heralding of the Renaissance. The feudal manors were breaking up and the serf of the feudal period was becoming the free labourer, the farmer and the merchant. The Black Death of 1348/49 removed a third of the population and placed a premium on the labourer's services. But the freedom of the serf led to a sharp division between the landless labourer toiling for wages, and the freehold or leasehold farmer. We have then, the spectacle of strikes and the formation of local Unions—a real foretaste of a later period. As yet there was no marked division between town and country and the townsman was still essentially a peasant in outlook and experience. The towns had as yet no slums.

We see also the infant beginning of the coal trade, with "sea coal" replacing wood charcoal in the homes. We also see the beginnings of the factory system, and the new cloth industry, based on homegrown wool, was the first English manufacturing industry. It was a breeding time for English capitalism, with commercial speculators and wool monopolists. There were few machines, but water power was coming into use for driving the new looms in the factories. We have the *entrepreneur*

collecting the raw material and passing the half-finished material from craftsman to craftsman, and finally to the market, though most industry still depended on the master craftsmen working in the villages.

With the Renaissance many changes occurred and we may next look at the Hanoverian period and Doctor Johnson's England (1740-1780). This was an age of aristocracy, but of liberty with the rule of Law. We see a growth of humanitarian feeling and of creative vigour in the trades and arts. Industry is stirring on the threshold of the Industrial Revolution.

Meantime, the insanitary conditions of life had caused a high death rate exceeding even the high birth rate. Population had increased but slowly, but with the growth of medical science a great change now occurred. The birth rate began to exceed the death rate and the growing population was one factor that contributed to the growth of industry. In the hundred years 1700-1800, the population nearly doubled and thereafter grew even faster; a market was being created. The union of coal and iron began; the steam engine arrived, transport improved rapidly, and, at the same time a revolution took place in agricultural methods. Agriculture developed rapidly alongside the growing industries, and continued to prosper under free trade till the coming of American wheat in the 1870's. England was mainly self-supporting, and manufactured goods for the world.

In the earlier part of this period however, and during the reign of George II. (1727-1760), manufacture was still mainly a function of country life, with the small craftsmen still working in the villages. Even at the time of Waterloo, England was mainly a rural community: such factories as there were scarcely marred the English countryside. The Napoleonic Wars gave a great urge to industry, at first for war-like purposes, but England's success and control of the seas led to a great expansion of overseas trade. The wealth of the community increased by leaps and bounds, but unfortunately the division of this wealth was unequal, and the wage earner fell on less happy times. And even worse, industry brought with it a new type of urban community and a mushroom growth that eventually led to the crowding of population and the slums. No longer need the village be self-contained: the cottage craftsmen gave place to the worker in the factory, and with improving communications the village could now obtain its goods from the town: the village craftsman became the village shopkeeper.

The rapidly increasing coal mining industry drew an increasing proportion of the population. The miners, although they earned relatively high wages, probably suffered more socially than any other section of the population. With long hours underground and the insanitary conditions of the mining villages, a bad tradition was created which is not yet forgotten.

I cannot now follow further the fascinating social history of the times, with its contradictions—improving medical services and insanitary conditions, good houses and slums—its educational and religious trends. It was a period of high endeavour by certain sections of the community, and the exploitation for gain of other factors by the less moral section of the community. Many writers of the period, such as Dickens and Matthew Arnold, led the way in exposing the abuses of the period, and it is to such men we owe the new social outlook of the present century.

We may with justification regard the year 1735 as marking the commencement

of our "Industrial Revolution". Essentially, the growth of industry was based on the union of coal and iron, and in 1735, the experiments of the Darby family of Coalbrookdale led to the successful smelting on a commercial scale of iron ore by coal coke. Developments were slow at first, but about 1800 began the tremendous surge of industry that still continues. Simultaneously came a rapid expansion of capitalism, the London money market and the joint stock companies.

On this background I may now attempt to draw the picture of the coal mining industry, and on the accompanying diagram (Fig. 1)* I have attempted to show you the principal events in its history. From 1735 to 1800 we have the infant stage. Output was still small—only 10,000,000 tons in the latter year, and this output was raised from many small shallow mines chiefly on Tyneside; attempts to go deeper were baffled by the water problem.

In 1712 Newcomen had built his first steam engine at a Staffordshire pit. This was the first practical steam engine, and its intention was to deal with the problem of unwatering mines. It achieved its purpose, and at once it became possible to carry mines to greater depth and extend the area of working and the size of collieries. The Newcomen engine was essentially a single-acting reciprocating pump; the idea of producing rotary motion for the driving of machines was yet to come. The first attempts to obtain rotary motion were to raise water by the Newcomen engine and deliver it to a water wheel which drove the machine, and this idea was developed to a considerable extent, both for colliery winding and for driving mills.

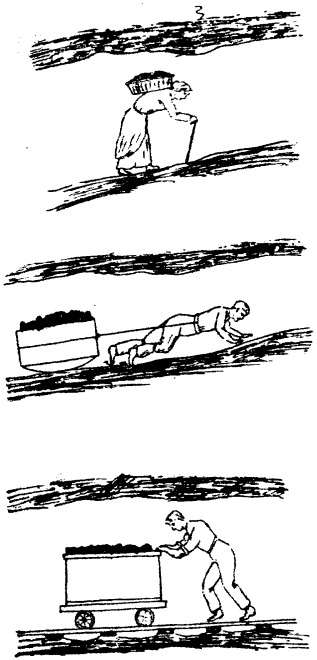
The credit for devising the first successful steam engine is popularly, but quite wrongly, attributed to James Watt. Watt's great credit lay in two directions. First, he devised the separate condenser and made his engine double-acting, thereby reducing coal consumption to one-quarter. Secondly, he applied his engine to producing a rotary motion, though even here, and to his chagrin, he was anticipated in the invention of the crank by Pickard's patent of 1780. Newcomen's steam engine was none the less a thoroughly practical pumping engine, which for 150 years was in widespread use. At least one—at Hemingfield in Yorkshire—still exists and was in intermittent use till 1923.

Amongst other inventions of our early period we may mention the use of horse haulage with wheeled trams running on rails (1753), the use of gunpowder for shaft sinking (1770), the invention by Curr of guides in the winding shaft (1790), and finally, the use of coal gas for lighting streets and houses in 1800.

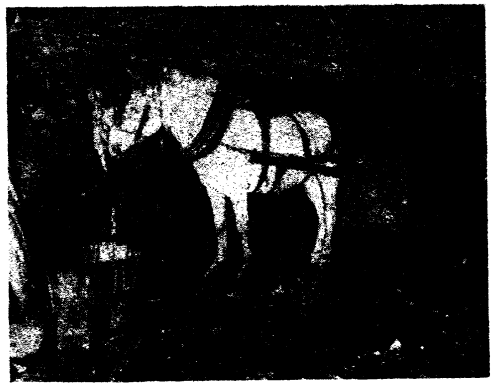
Between 1800 and 1830 we find the next big step forward—the invention of the locomotive—England's gift to the world. This is popularly attributed to Stephenson but Trevithick made the first practical engine in 1804, and Blenkinsop in 1812 produced a thoroughly useful locomotive which gave good service, particularly on Tyneside for many years.

What Stephenson did with his "Rocket" in 1829 was to design the forerunner of the modern locomotive with direct action on to the road wheels, and the locomotive type of tubular boiler with blast for the draught. With this engine came the rapid growth in railway systems, which made possible the transport of raw and finished materials from town to town and to the seaports, without which industry as we know it could not exist.

* See page 572



(*a*)
Early methods of haulage of coal



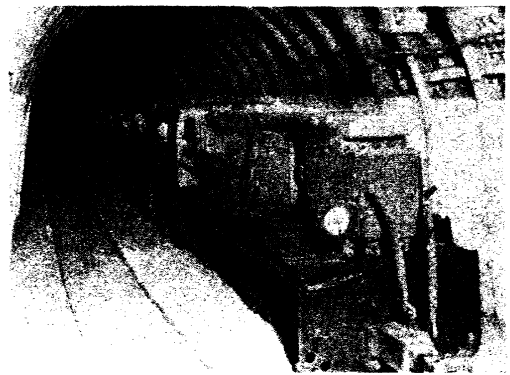
(*b*) *Pony haulage*



(*c*) *Underground endless rope haulage*
(*Reproduced by permission of the Safety in Mines Research Board*)



(*d*) *Belt conveyor in main road*
(*Reproduced by permission of the Safety in Mines Research Board*)



(*e*) *Diesel locomotive*
(*Reproduced by courtesy of the Hunslet Engine Co., Ltd.*)

FIG. 2.—*Methods of haulage of coal.*

With the railway age and the further development of the steam engine, came their application to uses underground in the mines for pumping and haulage. For winding coal the horse or water gin yielded to the steam winder. Cage winding with guides came in 1835, and with it the use of the modern mine tram, travelling on its own wheels from the coal face to the pit top. The wire rope came in 1841, and with it the possibility of handling greater outputs.

Collieries were now growing rapidly in size and number. About 1850 we find compressed air first used underground, and this type of power transmission quickly developed in collieries on quite modern lines. In 1882, following Siemens' invention of a practicable motor, the colliery industry inaugurated the electric age by introducing the electric motor underground, and the development of prime movers and boilers owed much to the enterprise of mining engineers seeking a form of power transmission which could be taken long distances underground. The end of the nineteenth century, in fact, found collieries well in the lead in the use of all forms of mechanical and electric power transmission and utilisation, with output soaring rapidly, till in 1913 over 280,000,000 tons were raised, a performance of which the industry may well be proud (Fig. 2).

Since 1913, the intervention of two world wars and the resultant economic chaos has resulted in a less happy story. Nevertheless, great progress in mechanisation has been made in recent years, and it is our hope that we are on the threshold of rapid advances in technique under the auspices of the National Coal Board. It must never be forgotten that, in any form of mining, man is engaged in a fight against natural forces, and it is not to be expected that progress can be so easy as it is in a surface factory. Great natural forces have to be overcome, and the miner is pitting his wits and his judgment against these largely unseen forces. Nowhere is this better illustrated than by studying the story of progress in safety underground, and even to-day, with all our knowledge, Nature often proves to be mistress. The early fight for safety was twofold—against firedamp and against water. Every schoolboy knows the story of Sir Humphrey Davy and the safety lamp, and this epochal discovery is perhaps paralleled in recent years by the invention of the flameproof electric motor designed to operate safely in inflammable atmospheres, with which we associate the name of Dr. R. V. Wheeler, Professor of Fuel Technology, University of Sheffield, a friend of Lord Cadman. Throughout the history of the period we find the usual disproportion between the enterprising colliery seeking greater safety and efficiency (and these go hand in hand in mining), and the laggard colliery; hence, from time to time Parliament has stepped in to compel the universal adoption of the highest standard of safety available at the period.

Finally, we may glance at the human side of our problem. Here we have a story of a growing humanitar an outlook, though not till the present century do we find the modern social outlook developing when the man is regarded as more important than the machine.

Our period opens with the miners tied to the mines in a state of semi-bondage. In 1825, with the legalisation of Trade Unions we find the beginning of the change; until 1890, however, the infant unions are fighting for better conditions (and often fighting each other), and then we have the formation of the Miners' Federation of Great Britain and the steady growth of that union into a powerful political force,

able and determined to lift the condition of its members to a position where their service is recognised by the nation. We see in rapid succession the Eight Hours Act, the Minimum Wage Act, and the institution of the Miners' Welfare Fund, which, by its establishment of pithead baths, has conferred great benefits on the mining community. Between the two world wars much mining legislation was directed to the improvement of the standard of living of the coal miner, and now the industry is in the hands of the National Coal Board, which is specially charged with the duty of securing the safety, health and welfare of persons in their employment.

It is not generally realised how great a change has taken place in the mining scene in the past 100 years, during which the miner has passed from an inferior status to a position where he is perhaps the most appreciated servant of the community.

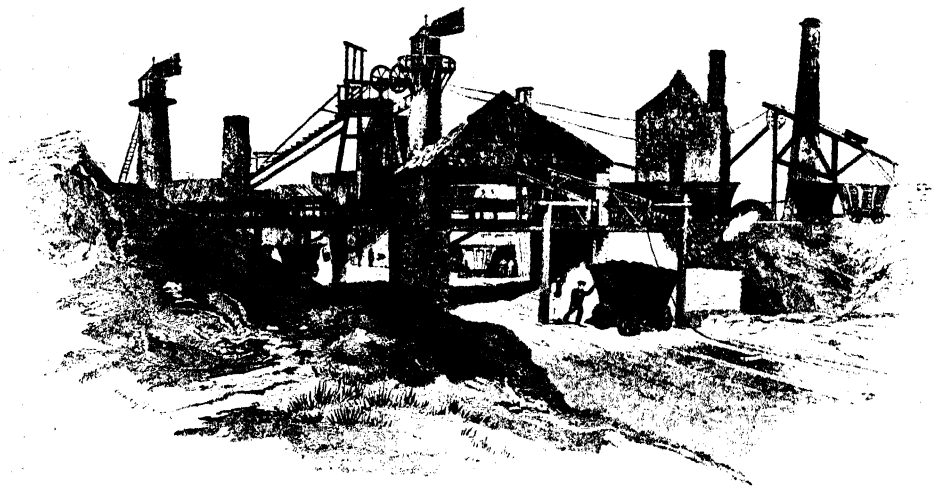


FIG. 3.—*Wallsend Colliery*, 1840

The miner is, indeed, entering a new era in a colliery which is very different from the colliery of 100 years ago (Figs. 3 and 4).

I have now drawn for you a brief picture of the mining scene and the developments of two centuries. We have seen the coming of the machine age; the gradual recognition of true social values based on a growing humanitarian outlook and a recognition of the duty of the community towards its fellow men; and, however disastrous have been the two world wars, they have, none the less, led to a quickening in thought, in invention and in social progress.

The Industrial Revolution was a period of intense individualism, and it was individuals rather than the community as a whole who led the way of progress. In the humanitarian field we see men like Lord Shaftesbury, arousing the conscience of the nation against the employment for long hours in mines of women and children; in the technical field we see inventors of the calibre of Newcomen, Watt, Stephenson and Humphrey Davy. Such men's names are attached to specific inventions or acts of progress. Other names we remember, not for specific deeds, but as men of stature, whose lives were devoted to progress in the whole field of their work. In mining we find names like Buddle, Nicholas Wood, the Atkinsons and

Garforth, who each in their own time advanced rapidly the science and art of mining.

Among these latter we must inscribe the name of Lord Cadman, and a survey of his career is amazing because of the wide variety of interests it covered. He was born at Silverdale, a small Staffordshire mining village on September 7th, 1877. He received his early education at Newcastle-under-Lyme, and leaving school at the age of seventeen was apprenticed at the collieries where his father, Mr. James Cope Cadman, was then General Manager. In 1896 he was awarded a Staffordshire County Council Scholarship which enabled him to continue his studies at the Durham College of Science, Newcastle-on-Tyne, where he obtained the degree of B.Sc. with First Class Honours. Here subsequently he obtained his M.Sc., and

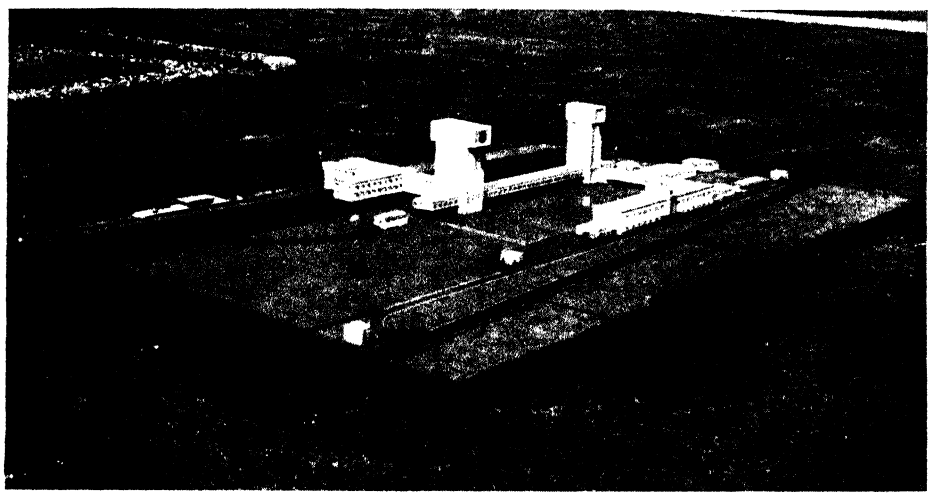


FIG. 4.—*Model of Rothes Colliery, commenced* 1947

finally, a D.Sc. As a youngster he went through the mill of hard practical experience. With this experience, and his natural qualities of self-reliance, perspicacity and perseverance amounting to genius, the foundations were laid for his subsequent career; and his loyalty to his friends and capacity for friendship combined with a charming personality to create the natural leader. He had a keen sense of humour and loved to tell and to hear a good story.

After experience in colliery management in Staffordshire and in Durham he became one of H.M. Inspectors of Mines, and his experience in this post left him with a deep interest in the human problems of mining: afterwards he did valuable research work for the Royal Commission on Mines, which reported in 1908. He also, at this time, contributed greatly to our understanding of coal-dust explosions. It was during his term of office in the Inspectorate, which brought the Scottish oil-shale mines to his notice, that he laid the foundation of his subsequent interest in petroleum. His work as one of H.M. Inspectors of Mines brought him to the notice of the Government, and with his appointment to the Colonial Office as Government Mining Engineer in Trinidad in 1904, he began his career as a Petroleum Engineer

as well as Mining Engineer: and thus laid the foundation of the successful pertoleum industry in Trinidad.

Shortly after his return to England in 1908 he was appointed to the Chair of Mining at Birmingham University, succeeding Professor Redmayne (now Sir R. Redmayne), and while there, developed the School of Petroleum Technology, which, for the first time, equipped this country with trained petroleum engineers at a time when the need for developing Great Britain's interest in petroleum was beginning to be felt.

In the first Cadman Memorial Lecture of the Institute of Petroleum last year Sir William Fraser traced the part played by Lord Cadman in the development of the British Oil Industry, his work in advising the Government and the commencement of the Anglo-Persian Oil Company, of which he became Chairman. It was indeed a great part, performed at a time of great need, and left his name a household word in the petroleum industry.

The memorial lectures of the Royal Society of Arts, of which he was a Life Fellow have been inaugurated by some of his many friends and admirers to commemorate his life and work in connection with coal, leaving the oil side to the Institute of Petroleum. I may be forgiven if I stress to-night more particularly the part he played in the coal-mining industry, in which he continued to take great interest.

At several collieries with the management of which he was intimately concerned, he modernised the methods of working, and he was a strong advocate of mechanisation. In his work for greater safety he was closely associated with the late Dr. J. S. Haldane, F.R.S., Professor of Physiology at Oxford, who shared his intense interest in coal, and his desire to help the miners. In a wider sphere, he strongly advocated the unification of the industry. He argued that the consumer was primarily interested in coal as a form of energy, and that the industry had the duty of supplying that energy in the most suitable form. He also advocated the extended use of gas and the use of smokeless fuel. He read a number of original papers before the Institution of Mining Engineers, and became President of that body in 1921, being later awarded the Institution medal. To the day of his death he maintained his interest in the technique and practice of mining.

He never regarded coal and oil as rival fuels, but with great prescience described the field for each in our national economy. He contended that the understanding of the scope for coal and its products was still in an early stage, and that the two great industries would continue side by side, and in full co-operation, each serving in a specialised field where its utility was of maximum service. He was one of the founders, and at one time President, of that meeting ground of all fuel technologists, the Institute of Fuel, who awarded him the Melchett medal.

Public recognition of his work was widespread, and a list of his honours and awards is interesting. He was awarded the Honorary Degrees of D.C.L. (Durham), LL.D. (Birmingham), and D.Eng. (Melbourne). At home he received the G.C.M.G. in 1928, and abroad was awarded the *Grand Officier Légion d'Honneur* (France); Knight Commander of the Crown of Italy; Order of the Rafidian, Class I. (Iraq); and Pasha First Class (Transjordan). In 1937 he was created first Baron of Silverdale.

In 1938, he was awarded the Freedom of the Borough of Newcastle-under-Lyme,

and in 1940 he was elected a Fellow of the Royal Society, He was a member of many scientific societies. He was, at different times, President of the Society of British Gas Industries, of the Institute of Petroleum, and Vice-President of the Geological Society and of the British Association for the Advancement of Science. Of particular interest to us was his Presidency of the Institution of Mining Engineers and of the Institute of Fuel. He was a member of many Government Committees; during the first World War he was Chairman of the Inter-Allied Petroleum Council. He was a member of the Safety in Mines Research Board; the Fuel Research Board (D.S.I.R.); the Prime Minister's Economic Advisory Council (1932-41), and the Post Office Advisory Council; he was Chairman of the Civil Aviation Enquiry, 1938, and of the Television Advisory Committee, 1939. And even this list is incomplete.

On the outbreak of the last war he at once offered his help to the Government and became the first Chairman of the Scientific Advisory Council of the Ministry of Supply. Unfortunately, he overtaxed his strength and, in 1941, died prematurely at the age of 64. So ended a life of hard work and leadership in many fields.

As a Nation we are perhaps fortunate in that we seem to throw up the right men in the hour of need. May we continue to be so fortunate, and find men of the calibre and purpose of Lord Cadman in the difficult times that lie ahead.

At the conclusion of the lecture Professor Hay showed a film entitled " The New Mine."

THE CHAIRMAN: Before we part I am sure you would wish to express your thanks—and I should like to express mine—to Professor Hay for his interesting lecture. During the lecture I wondered whether Professor Hay might be thinking, during the next five or ten years, of preparing another diagram which would, I hope, represent the progress made by the National Coal Board during that time. The diagram which may be produced in 150 years' time will not be his affair, nor will I be present to see it, but I cannot think what pits will look like even in fifty years' time. We are going on and trying to progress. People seem to think that we can do in five years all the things which have before taken 150 years to do. Believe me, we shall make progress, but it must be a long drawn-out performance.

Professor Hay, I thank you on behalf of all present for your most interesting lecture.

The vote of thanks was carried with acclamation.

Major CADMAN: Before I propose a vote of thanks to the Chairman for presiding this afternoon I should like to mention that these Memorial Lectures of the Royal Society of Arts will be given every two years. I therefore hope that the suggestion which the Chairman has put forward will be borne in mind, and that at even shorter intervals than fifty years we shall be kept appraised of progress in helping to restore the mining industry to production. We are greatly indebted to Professor Hay for this lecture and we appreciated the really manificent film he showed us; I think it should be shown all over the country.

It only remains for me to propose, on behalf of the Council of the Royal Society of Arts and on behalf of the many members of the Cadman family and friends of Lord Cadman who are here, a very hearty vote of thanks to the Chairman of the National Coal Board for so kindly sparing the time to come here this afternoon. He is one of the busiest men in the country to-day. We do appreciate his being here and we thank him most sincerely.

The vote of thanks was carried with acclamation, and the meeting then terminated.

CORRESPONDENCE

CRAFTSMANSHIP

I have been most interested in Mr. Capey's paper on "Craftsmanship" as it deals with a theme that ought to give plenty of matter for thought to every cultured mind. At the present moment I am trying to give a definite form to some ideas on "Manual Training" as a part of the Common Education; I feel happy indeed in finding that Mr. Capey's remarks reinforce my own, and so they reassure me of the rightness of these.

However, in the present case, my admiration for the paper is a little—very little—impaired by an answer given by Mr. Capey to Mr. L. J. E. Hooper during the discussion, he said: "South America, I believe, is an interesting country, but the people there are inclined to accept what is given to them without expressing any personal desires".

I beg the author to excuse my feeling that it is a little too hard for a South American to accept that it it is necessary to gather into a bunch the ten different nationalities of this part of America, to make one country; and let me remind you that Argentina, for instance, has been populated from its origin by European immigrants, and so the qualities and defects of the generations born from them are those of their ancestors.

As for our acceptance of what is given to us "without expressing any personal desires", it would take a long while to discuss the value of what seems to be too emphatic an affirmation. Let me put instead a question to Mr. Capey as an end to this letter: Does he believe that we have been mistaken when we have bought Bradford's woollens and Manchester's cottons as we have done for many years, without expressing our personal desires? Was not the cause for our accepting them without discussion, the fact that we knew that those goods were the best obtainable?

Martinez, Argentina. RICARDO J. GUTIERREZ.

GENERAL NOTE

INTERNATIONAL EXHIBITION OF BOOK DESIGN.—As Mr. Gerard Hopkins remarks in his foreword to a valuable and timely booklet on the problems facing the book trade,* the shortages from which publishers suffer have become matter of public knowledge and publicized debate. How successful British publishers have been in making attractive bricks out of the meagre supply of straw doled out by a grudging Government Department we have seen in many remarkable productions issued during the past few years; and visitors to the second International Exhibition of Book Design, which is open until the end of the month and which has been arranged by the National Book League at their headquarters at 7, Albemarle Street, Piccadilly, will observe with particular satisfaction that some 80 choice examples of the printers' and binders' craft, published in Great Britain during 1946, compare favourably with selections from ten other countries—including the U.S.A., where production is almost entirely unrestricted.

This year the selection of the British books has been entrusted to a single adjudicator, Mr. Walter Lewis (formerly University Printer at Cambridge), who, appreciating the exceptional difficulties of the present time, has wisely been more concerned with good design, composition and presswork than with the quality of paper and binding. A fair proportion of his choices, nevertheless, attains a pre-war standard in every respect; and Hans Feibusch's *Mural Painting*, set in Poliphilus with excellent half-tone blocks (A. and C. Black), Bettina's wholly enchanting children's book *Carmello* (Chatto), *The Poems of Francois Villon*, a production of outstanding merit illustrated by Ardizzone (Cresset Press) and V. Sackville-West's *The Garden*, with its attractive jacket and end-papers (Michael Joseph) may be mentioned as a few books which would have

* The Battle of the Books. Edited by Gerard Hopkins. Allan Wingate. 1947. 2s. 6d.

commended themselves to the perspicacious Symons of the First Edition Club in years gone by.

Every selection—however authoritative the adjudicators may be—is necessarily arbitrary, and it would be unfair to award the palm for choice book-production to any country on this showing, but the recent books chosen by the Czech cultural attaché are unquestionably among the finest in the exhibition.

Specially memorable are *The Lay of Igor's Host* and *Erben's Fairy Tales* (English titles are given) finely printed and with exquisite jackets, and several other Czech publications are notable for the high standard of colour printing.

From Northern Europe and Scandinavia come some lovely examples of imaginative craftsmanship; and a beautifully printed collection of lyric death poetry, published in Utrecht, provides an example of the resourcefulness of Dutch publishers in spite of economic stress. Historical and propaganda as much as aesthetic considerations appear to have dictated the choice of Russian books, and characteristic examples of native craftsmanship have also been loaned by Canada, the U.S.A., France and Egypt.

N. A. D. WALLIS.



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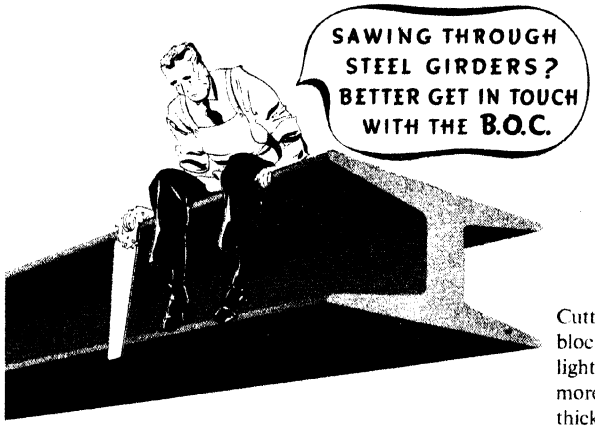
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JOURNAL OF THE ROYAL SOCIETY OF ARTS

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CHAIRMAN OF COUNCIL

At the meeting of the Council held on Monday, July 21st, Sir Harry Lindsay, K.C.I.E., C.B.E., was unanimously elected Chairman of the Council.

MEETING OF COUNCIL

A meeting of Council was held on Monday, July 14th, 1947. Present: Sir Harry Lindsay (in the Chair); Lord Aberconway; Sir Alexander Aikman; Mr. F. H. Andrews; Sir Frank Brown; Major W. H. Cadman; Sir Edward Crowe; Sir Thomas Dunlop; Sir Edward Gait; Professor C. S. Gibson; Sir William Halcrow; Dame Caroline Haslett; Dr. R. W. Holland; Sir Henry McMahon; Mr. G. K. Menzies; Mr. F. A. Mercer; Mr. J. A. Milne; Sir Ernest Pooley; Mr. J. W. Ramsbottom; Mr. E. M. Rich; Mr. A. R. N. Roberts; Mr. E. Munro Runtz; Mr. Gordon Russell; Captain A. H. Ryley; Sir Frank Smith; Mr. William Will; Mr. J. G. Wilson and Miss Anna Zinkeisen; with Mr. K. W. Luckhurst (Secretary) and Mr. C. J. Buchanan-Dunlop (Assistant Secretary).

Sir Harry Lindsay was unanimously elected Chairman of Council for the year 1947–48.

The following candidates were duly elected Fellows of the Society:—

Baldwin, Ira Lawrence, M.S., PH.D., Wisconsin, U.S.A.
Benz, Norman, M.A., Eastbourne, Sussex.
Bogle, James Main Linton, M.C., B.ENG., London.
Cawston, Captain Samuel Antony Roberts, Ashanti, West Africa.
Clarkson, Sidney, Huddersfield, Yorkshire.
Dandridge, Michael Percy, London.
Goodall, Charles Montague, O.B.E., M.C., Harrogate, Yorkshire.
Gothard, Clifford Frederic, J.P., Burton-on-Trent, Staffs.
Grant, Professor Kerr, M.SC., St. Peters, South Australia.
Hancock, Charles Ernest, B.COM., Teddington, Middlesex.
Henning, Paul, London.
Hollings, Harold, D.SC., London.
Jung, Nawab Mir Nawaz, London.
Kidd, Arthur William Graham, London.
Lamb, George, Morecambe, Lancs.
Langmaid, Claude William, Halesworth, Suffolk.
Lupton, Hugh Ralph, M.C., M.A., Kew, Surrey.
McCance, Andrew, D.SC., F.R.S., Carmunnock, Lanarkshire.
McGregor, John Alexander, B.SC., Paisley, Scotland.
Mackrill, Hubert Alfred, Worcester.
MacNair, Brigadier James Lewis Pugh, Ruckinge, Kent.

Marconi, Marchese Giulio, Rome, Italy.
Mather, Mrs. Sheila Margaret, Chesterfield, Derbyshire.
Molony, Rev. Canon Brian Charles, O.B.E., T.D., M.A., Worksop, Notts.
Murray, James Hutchinson, Paisley, Renfrewshire.
Naismith, Norman Vaughan, London.
Neate, Commander Charles Eden, R.N.(RETD.), Folkestone, Kent.
Norrish, Professor Ronald George Wreyfus, PH.D., SC.D., F.R.S., Cambridge.
Pollard, Henry, Dartford, Kent.
Richardson, Professor Arthur Vernon, M.A., D.C.L., Quebec, Canada.
Roscoe, Reginald Victor, Pinner, Middlesex.
Rowe, Norbert Edward, C.B.E., D.I.C., B.SC., Hutton, Essex.
Saniter, Frank Henry, B.ENG., Sheffield.
Sarnoff, Brigadier-General David, New York, U.S.A.
Saunders, Eric George, London,
Saunders, Sir Harold Leonard, B.SC., London.
Shaw, Miss Edna Jane, Manchester.
Sherlock-Mesher, Arthur Edmond, London.
Sherwood, The Right Hon. Lord, London.
Shipwright, Squadron Leader Denis Ewart Bernard Kingston, Woking, Surrey.
Slinger, Dudley Melville Patrick, Grenada, B.W.I.
Tabraham, Edmund Hugh, Wallington, Surrey.
Telford, George Edmund, Pangbourne, Berkshire.
Tovey, Admiral of the Fleet Lord, G.C.B., K.B.E., D.S.O., Woking, Surrey.
Upton, Charles Marsden, Titchfield, Hants.
Westwood, Captain Reginald Wellesley, R.A.S.C., Streetly, Staffs.
Woodhead, Sir John Ackroyd, G.C.I.E., K.C.S.I., Woking, Surrey.

The standing Committees were reappointed for the new Session.

Silver Medals were awarded for papers read during the past Session (see p. 591).

It was decided to appoint a Committee, under the Chairmanship of Mr. Gordon Russell, R.D.I., to enquire into the present decay of craftsmanship and report on any action which might be taken by the Society in regard to it.

It was reported that the number of entries for the July examinations was 34,052, making a total for the year of 87,992, compared with 80,345 last year.

A quantity of formal and financial business was transacted.

A TRIBUTE TO THE LATE VISCOUNT BENNETT

At the opening of the Council Meeting on July 14th, Sir Edward Crowe paid a tribute to the late President. After describing how Lord Bennett came to settle in this country and how he joined the Society, he referred to his membership of the Council, and to his election as President in July, 1945 on his 75th birthday. Sir Edward then went on to cite examples of Lord Bennett's work for the Society, as a Chairman at its meetings, as a lecturer, and in the supervision of its routine affairs. He described the generosity of the late President both in gifts and hospitality and he concluded in the following words:

"But when all is said and done I think he was at his best in the intimacy of a small committee or council meeting. His mastery in the gentle art of leg-pulling was such that we all enjoyed it and no one ever took offence: and he himself really got a great deal of fun out of it too—particularly when he had a chance to chaff his old friend "Balliol".*

* "Balliol" refers to Mr. G. K. Menzies, the former Secretary.

"Those of us who were fortunate enough to have been present on these occasions will treasure the memory of a grand old gentleman imbued with a deep respect for the dignity and prestige of the Society, statesmanlike, learned, wise, fair-minded, courteous and considerate; but all the time this was interwoven with, and illuminated by, a boyish spirit of fun.

"His last public appearance was with us at our Annual General Meeting surrounded by his friends—so it may be said that he died in harness as he would have wished.

"A devout Christian lies at rest in the beautiful churchyard near his new home. May he rest in peace".

After Sir Edward Crowe had spoken, Sir Henry McMahon, Mr. J. A. Milne and Mr. E. M. Rich added their appreciations.

AWARD OF SILVER MEDALS TO LECTURERS

The Council have awarded silver medals for the Session 1946–47 to the following lecturers:

For Papers read at Ordinary Meetings

Miss E. Kay Kohler, A.T.D., "Embroidery as an Expression of National Characteristics".

Sir Stephen Tallents, K.C.M.G., C.B., C.B.E., "The Documentary Film". (*Cobb Lecture*).

L. H. Lampitt, D.SC., F.R.I.C., "Sir William Jackson Pope: His Influence on Scientific Organisation". (*Sir William Jackson Pope Memorial Lecture*).

Sir Charles Lidbury, "Great Britain in Relation to the World's Trade Situation".

Sir Harold Hartley, K.C.V.O., C.B.E., M.C., F.R.S., "A Century of Chemistry".

A. H. Ensor, "Finance and the Use of Money".

Professor Douglas Hay, M.C., B.SC., M.I.C.E., "British Coal Mining and the Industrial Revolution: With Special Reference to the Life and Work of the late Lord Cadman". (*Cadman Memorial Lecture.*)

A. J. Turner, M.A., D.SC., "Flax Utilisation".

Right Hon. Oliver Lyttleton, D.S.O., M.C., M.P., "Production".

Sir H. Spencer Jones, M.A., SC.D., F.R.S., "Modern Astronomical Instruments". (*Trueman Wood Lecture.*)

Sir Kenneth Clark, K.C.B., "International Gothic and Italian Renaissance Painting". (*Selwyn Brinton Lecture.*)

For Papers read before the India and Burma Section

Brigadier J. F. Bowerman, C.B.E., "The Frontier Areas of Burma".

Sir Herbert Howard, "The Forests and Forest Resources of India".

Sir Kenneth G. Mitchell, K.C.I.E., "Roads and Road Transport in India".

For Papers read before the Dominions and Colonies Section

The Right Hon. Lord Elton, "The Work of the Rhodes Trust".

S. Herbert Frankel, M.A., PH.D., D.SC., "Whither South Africa?—An Economic Approach".

Professor T. S. Simey, "Social Welfare in the West Indies".

CENTENARY OF THE CHEMICAL SOCIETY

Sir Harry Lindsay as Chairman of the Council presented the Society's Address to the Chemical Society on the occasion of their centenary celebrations. The ceremony took place on Tuesday, July 15th, at the Central Hall, Westminster. The following is the text of the address:

" To the Chemical Society of London.

"The Royal Society of Arts is particularly happy and proud in presenting Greetings to the Chemical Society on the Celebration of the Centenary of its Foundation, since it was in the rooms of the Royal Society of Arts that the Chemical Society came into being on 30th March, 1841, and had its home for more than seven years. The happy relations thus established have continued throughout the intervening century.

"The distinguished work accomplished by the Fellows of the Chemical Society—the Senior of all Societies devoted to the Advancement of Chemistry—calls forth universal admiration. Brilliant achievements in every branch of Chemistry have been recorded at its meetings and in its publications, and its Fellows have made a full contribution to the progress of the Science of Chemistry during more than one hundred years.

"The Royal Society of Arts believes that the Chemical Society is destined to play a still greater part in chemical discovery and expresses the hope that its work in the future will continue to confer ever-increasing benefits on mankind.

"In faith and testimony whereof the Royal Society of Arts has caused its Seal to be affixed hereto and this Address to be signed by its Chairman of Council and a Vice-President and countersigned by its Secretary on the 15th day of July, A.D. 1947".

CENTENARY OF 1851 EXHIBITION

Mr. H. A. Marquand, M.P., the Paymaster-General, on behalf of the Lord President of the Council, received the Society's International Exhibition Committee on Wednesday, July 16, to discuss with them the plans for celebrating the centenary of the Great Exhibition of 1851. The Committee was represented by Viscount Samuel (Chairman), Sir Harry Lindsay (Chairman of Council), Lord Aberconway and Mr. A. C. Bossom, M.P. The Secretary, Mr. K. W. Luckhurst, also attended.

The Committee offered some suggestions relative to the working out of the projects adumbrated by the President of the Board of Trade in his Parliamentary reply of March 28th. They also urged the Government to arrange for a definite date to be set for the International Exhibition originally planned for 1951 but recently postponed owing to present economic conditions. The Paymaster-General promised consideration of the various points made by the Committee.

ROADS AND ROAD TRANSPORT IN INDIA

By Sir KENNETH MITCHELL, K.C.I.E., M.I.C.E., M.INST.T.
Late Chief Controller, Road Transport and Development, India

India and Burma Section, Thursday, March 6th, 1947

Colonel L. E. BARTON, C.I.E., *in the Chair*

THE CHAIRMAN: In the unfortunate, but unavoidable, absence of Sir Frank Noyce, I have been asked to take the Chair this afternoon.

It is with very great pleasure that I introduce to you an old friend, Sir Kenneth Mitchell. I think most of those present will know what an enormous amount of work he has done for road communications in India, and what an expert and authority he is on his subject. I am sure we shall hear an extremely interesting address.

Sir KENNETH MITCHELL then read the following paper:

To begin with, I am, by the courtesy of *The Times*, able to show you a picture[1] of a model of a bullock cart reconstructed from the remains found in the Mohenjo-daro excavations; that is to say, of the bullock cart of 5,000 years ago. Roads and road transport in India are, indeed, as old as her civilisations and dynasties, with which they have waxed and waned, but prior to the nineteenth century there was probably little or no artificial surfacing outside the towns and very little bridging. Large-scale road building began in British India *circa* 1830, from which date the Grand Trunk road and other large works were undertaken and the Public Works Department was created. Following the then recent work of Macadam and Telford, the main roads were metalled, but bridging was at the least possible cost.

Road building, however, had but a short start in time from railways. The first railway from Bombay to Thana, twenty-two miles, was opened in April, 1853, and others quickly followed. Railways had three effects on roads. First, they duplicated many of the better roads because, naturally, they followed the most active traffic routes, along which, also naturally, roads had often first been made. Secondly, the importance of roads fell in the general estimation; and thirdly, and at the same time, railways created immense new road traffic. As a result, by *circa* 1920 when rural motor transport began, there were only about 50,000 miles of metalled roads against nearly 30,000 miles of railways, and many of the railways and metalled roads served the same routes. There were also about 130,000 miles of earth road maintained by public authority[2], but generally in very bad order.

Clearly, before there were railways, traffic on local roads was light and seasonal, since, except within reach of natural waterways, farming was for subsistence and the village a self-contained unit. As emphasized by the Royal Commission on Agriculture in India, it was the railways that revolutionized agriculture, by making possible the growing of money crops, followed by the great self-financing schemes of irrigation, which, with the new seeds and methods of agricultural departments, further swelled the volume of exportable staples. Railways, again, led to heavy industries and large urban populations to be fed; and later to mutual stimulation of industry and agriculture as in the case of cotton, or, more recently, sugar. Railways and public health measures together greatly reduced the ravages of famine and disease. To the thus rising population, greater security and the facilities of the railways opened new prospects of, and needs to, travel: in the migration of labour to and from industry, on pilgrimages, for marriages and on other social occasions. All, or virtually all, of this great increase in movement of men and things began or ended over the local roads, causing ever-growing wear and tear. Thus, there are now nearly six-and-a-half million bullock carts in British India[3]. It may here be added that there are probably 130,000 motor vehicles of all sorts[4]; or say, in round

[1]The picture appears on p. ix of the " British India and Indian States " section of *The Times Trade and Engineering Review* of April, 1939. It is not reproduced in the *Journal*.

[2]Excluding a large mileage of village lanes and tracks often, in some sort, common village property.

[3]"Proposals for an All-India Survey of Bullock Carts by Means of Random Sampling", by J. Vesugar. *Proceedings Indian Roads Congress*, Vol. VIII, Part I, October, 1943.

[4]This figure may be somewhat wide of the mark. It is difficult to estimate, on the one hand, the recent civil absorption of surplus military vehicles, and, on the other, the discards of pre-war models.

figures, fifty carts to every motor vehicle, one cart for every forty-five and one motor vehicle for every 2,250 of the population.

THE BULLOCK CART

Compared with its ancestor of 5,000 years ago, the cart does not seem to have changed greatly except, to the road-builder, for the worse. Animal husbandry has improved the breeds of cattle, for which and other reasons the cart to-day carries heavier loads. The disc wheel is now rare and, except in parts of the United Provinces and the Punjab where the farmer's cart has a wheel with four twin spokes and a deep, rigid wooden felloe, has been replaced by an artillery-type iron-tyred wheel. The narrow tyres subject the road to an intensity of pressure, measured in pounds per inch width of tyre, much in excess of that permitted, say, in Britain when iron-tyred carts and wagons predominated. Moreover axle-bearings are often so loose that the wheel may travel virtually on one or other edge of the tyre and every now and then add a vicious twist to the already intense bearing pressure. Lastly, and this is a more important feature than may appear, each of the pair of bullocks walks exactly in front of each of the wheels, a cause among others of intense tracking and rapid wear into ruts. Earth roads have been worn down to a level below the natural ground surface, becoming drainages in the monsoon or ponds when irrigation channels breach; they are often a serious handicap to agricultural marketing and impassable for any vehicle except the cart. The wear and tear of metalled roads caused the costs of maintenance to rise and District Boards were already fighting a losing battle when, with motor transport, accelerated wear set in. Motor traffic is by nature severe on ordinary stone metalling, but the combined effect on that surface of cart and motor traffic exceeds the sum of the two severally, since the motor vehicles disperse the protective cushion of dust and "fines" formed by the crushing action of the iron tyres. India cannot at present afford the luxury of dual roadways for motor and cart traffic, save in exceptional local circumstances, and the search for a dual-purpose specification has been difficult. I shall return presently to the probable future of the bullock cart and to the types of surface so far evolved. I will here only mention the significant fact that in the only test-track at present in use in India, at Calcutta, to observe road wear under quasi-laboratory conditions, the apparatus is designed to reproduce the action not, as in other countries, of heavy motor traffic, but of the bullock cart.

During the period of increasing volume of traffic and unit loads, the charge of local roads devolved upon local bodies, and, by the year 1926–27 80 per cent. of all roads and 57 per cent. of metalled roads were in charge of District Boards. With the exception of Madras, the bad condition of District Board roads is notorious and eloquent of the need for reform. No useful purpose would be served by attempting a species of post-mortem examination here. It will suffice to point to the inelastic resources of those bodies in the face of growing demands for roads, education and public health measures; to state that to nothing is the old saw about a stitch in time so apposite as it is to the maintenance of cheap roads; and to hazard the opinion that local bodies in India have enjoyed an extraordinary degree of freedom from external supervision and interference. It is, I believe, now beyond dispute that to bring the road system into line with the needs of to-day requires not only the use

of new methods and materials of construction, but also reform of the system of administration and finance.

BRIDGING

Mention has been made of strict economy in the past in standards of bridging. Except where spanned by railway bridges, major rivers have been as inland seas. To a small extent road bridges have been combined with railway bridges. The least costly form of combination is that with rail and road on the same deck. Where the railway bridge is of the "deck-type", that is, the track on top of the main girders, satisfactory combination of a road bridge is rarely possible, because the main girders are spaced at approximately the railway gauge, centre to centre, and the whole is therefore too narrow for an adequate roadway and side protection.

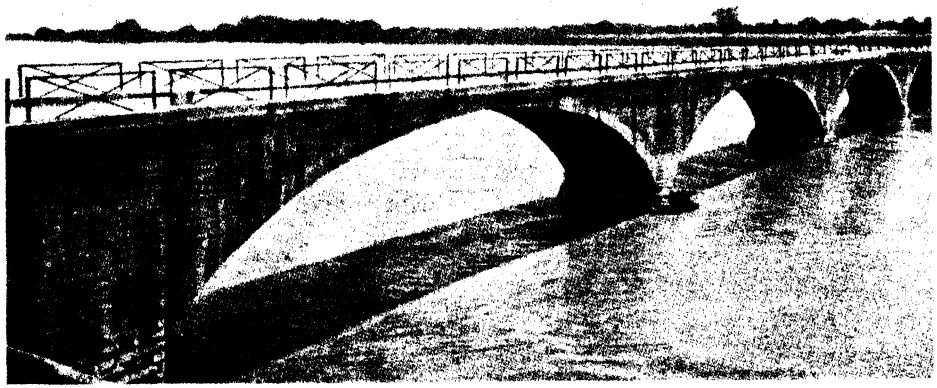


FIG. 1.—*Submersible bridge over River Wainganga, Central Provinces, 18 spans, 86 ft. centres, reinforced concrete arches, total length 1,650 feet. The railings are collapsible and are dropped into slots when a flood threatens to top the bridge*

Common-deck combination is possible with a "through-type" railway girder, but the roadway is even then narrow, inconvenient, and a source of danger. Cantilever combinations are better, but are expensive if the two separate roadways are to be wide enough for overtaking and passing; and the most satisfactory arrangement is probably that in which the road is carried above the railway. Except for a few combined bridges and very few separate road bridges, roads cross major rivers, if at all, by pontoon bridge erected in October as the floods fall and dismantled in May before they rise. Medium-sized rivers have low flush or pierced causeways, liable to prolonged or total interruption during the monsoon; and minor drainages are often crossed by Irish bridges. Ferries are operated at important bridgeless crossings or where they are interrupted by the monsoon, but, save in rare cases where there is still water, the current is generally too swift and landing places too unstable for anything very satisfactory. There are a few steam ferries, some of which are much hampered by instability of landing-sites. Much has been done

during the last twenty years to improve bridging, but much more remains to be done; and, in the programme of the future, the possibilities of the combined road and railway bridge will doubtless be exploited as far as engineering, traffic and safety conditions allow.

Commercial Motors

Motor transport for gain began after the 1914–18 war, mainly for passengers on somewhat ramshackle military surplus vehicles. At first they operated on short runs, very often on earth roads, between towns and outlying places off the railway. The old vehicles soon wore out and owners found that, with new and larger buses obtained on hire-purchase, main-road running was more profitable. The apparent profits being made attracted others and competition began to set in, of which more later.

That, in rough outline, was the position when, in 1927, moved by a resolution in the Council of State, the Government of India set up a committee of the Indian Legislature, presided over by Mr. M. R. Jayakar, M.L.A., to advise on road development; and eventually, in 1930, on the recommendation of that committee[5] and with the concurrence of Provinces, created the Central Road Fund, provided by an addition of two, later raised to two-and-a-half, annas to the taxes of Customs and Excise on petrol; and set up a small central office for co-ordination of schemes, research and intelligence. By a resolution of the Central Legislature it was provided, among other things, that 10 (later 15) per cent. of the fund should be reserved to the Central Government for discretionary grants, research and intelligence; the balance being allocated to Provinces and States on the basis of their petrol consumption, but to be used only on schemes of development approved by the Central Government with the advice of a standing committee for roads of the Indian Legislature.

Within a year of the creation of the Road Fund world depression was reflected in decline both of railway receipts and of provincial revenues, so that, on the one hand, the inroads of motor transport assumed for the Central Government a more ominous aspect, and, on the other, Provincial Governments were impelled to regard the Road Fund not so much as new money for the development of new surfaced roads complementary to railways, but as a fortunate release from the necessity of providing from straitened budgets for current expenditure on the improvement of their existing surfaced roads, often parallel with railways, rendered necessary by increasing motor traffic: and even, in extreme cases, for ordinary maintenance. At the same time internal competition between motor buses had brought their fares down to below the third-class railway fare and railways had begun counter-competition by fare cutting and otherwise.

The Provinces and the Centre

This is not the place for any attempt to discuss the merits of the complex tangle of road and rail, but it is necessary to refer briefly to the aggravations of that already difficult matter arising out of the constitutional and other factors in India. What is

[5] *Report of the Indian Road Development Committee*, 1927–28, Government of India Central Publications Branch, Calcutta.

called the lack of balance in the road system has been mentioned. A survey made in 1932[6] showed that, on the average, in the then nine, now eleven, Governors' Provinces that make up over 90 per cent. of the area of British India, 22 per cent. of the mileage of metalled roads, or 30 per cent. if Madras is excluded, were fairly closely parallel to a railway, and that, conversely, 48 per cent. of the total mileage of railways had a parallel metalled road, the extreme cases being the North-West Frontier Province and the Central Provinces with 94 and 73 per cent. respectively of the railway mileage having a parallel metalled road. Given an extensive road and rail system, duplication of road and rail links is of course natural and inevitable. The significance of these figures lies in the fact that they relate to metalled roads only, themselves only 28 per cent. of the total road mileage; and that of those the larger proportion of the mileage parallel with a railway was made up of P.W.D trunk roads in good order, and the majority of the others, of District Board roads, some in very bad order. Thus, speaking generally, motor transport found its scope restricted to a great extent to direct competition with railways, and the Central Government, responsible for the railways, had a direct interest in promoting the development of roads complementary to them. Constitutionally, also, the position was complex. Railways are a central subject and are, moreover, now practically wholly owned by the Central Government. Roads are a provincial subject, although the centre is competent to, and does, make grants for road development. The control of motor transport is in Part I of the list of concurrent legislative competence, which means that, while the Central and the Provincial legislatures have power to enact laws, the executive authority is exclusively Provincial. Taxation of motor vehicles is Provincial; but the revenue derived from taxes of Customs and Excise on motor spirit, and the power to determine the level of those taxes from time to time, are Central. From the point of view of road and transport development and of those who have to work to that end, it is to be hoped that the provisions of the new constitution will be more simple and realistic. The expectation of impending change has, in the meantime, if possible, added to the difficulties.

Indian railways have in the past relied largely on their earnings from third-class passengers, and nearly 40 per cent. of those earnings were derived from travel in the zone 1–50 miles[7]. Speed was not so important as cost; and the low third-class fare of two-and-a-half to three pies per passenger mile was achieved with infrequent heavy and slow trains. It is noteworthy that, as pointed out by the Indian Railway Enquiry Committee, passenger fares are lower in India than in eight other countries out of nine taken for comparison, and goods freights lower than all save three, the United States, Canada and Japan[8]. Even so, diversion to the roads of a substantial

[6] *Report on the Present State of Road and Railway Competition and the Possibilities of their Future Co-ordination and Development, and cognate matters in Governors' Provinces*, by K. G. Mitchell and L. H. Kirkness (briefly the *Mitchell-Kirkness Report*), Calcutta, Government of India Central Publication Branch, para. 4, page 4.

[7] *Mitchell-Kirkness Report*, page 49.

[8] The following is an extract from the *Report of the Indian Railway Enquiry Committee*, 1937. Manager of Publications, Delhi, para. 15, page 11.

"In the volume of statistics published by the International Union of Railways for 1935 a comparative table is given showing the average charge for passengers and for goods respectively in all the more important countries of the world. The figures are given on a comparable gold basis in centimes per passenger-kilometre and per ton-kilometre. We extract the following · (*Continued overleaf.*)

portion of the passenger traffic in the zone 1–50 miles was threatened. In 1932 the "losses" of railways to the roads were believed to be less than two crores of rupees a year, that is, less than 2 per cent. of normal receipts.[9] In 1937 the Indian Railway Inquiry Committee put the figure at four-and-a-half crores of rupees, of which three-quarters of a crore was in goods traffic[10].

THE TRANSPORT ADVISORY COUNCIL

The Central Government thus felt it necessary to take stock of their position and to require adequate regulation and co-ordination before they could freely support the much-needed programme of road development. This was natural. It was not due solely, as it was at times said, to a desire to protect their Achilles' heel of railway finances, but because solvent railways, and low rates and fares, are necessary to general prosperity. They have steadily pursued that aim, first in a Road Rail Conference of 1933 and subsequently in the Transport Advisory Council. This is a purely Government body on which Provincial Ministers or their representatives, and advisers, sit with representatives of the Central Government with the object of teaching and maintaining a common policy. By 1937, despite some continuing differences regarding the use of the Road Fund, the council accepted the draft of a Bill to be introduced in the Central Legislature amending and consolidating the law relating to motor vehicles. This includes a chapter on the regulation of transport which, as it emerged from the legislature as the Motor Vehicles Act, 1939, is not in essence a co-ordinating Act, but sets up a system of control by statutory authorities through the issue of permits, upon which co-ordinating provisions can be grafted. A Bill with this object is now before the legislature. The war prevented development in road plans, but in 1943 post-war plans were begun and tentative proposals were made public in two reports on transport and roads respectively[11], and in 1944–45 the Central Government placed proposals before Provinces, the outline of which is as follows:

Roads would be classed as National Highways—the main trunks for inter-Provincial communications and defence—, Provincial Highways—the remaining inter-district trunks—, District roads, and Village roads. For their part, the Central

Country	*Average receipt per*	
	Passenger Kilometre	*Ton Kilometre*
Italy	4·14	4·56
Germany	2·96	4·32
Great Britain	2·39	4·83
France	2·41	4·49
South Africa	—	3·26
Canada	3·98	1·84
U.S.A.	3·69	1·84
Argentine Republic	2·02	2·57
India	1·25	2·50
Japan	1·00	1·39"

[9] *Mitchell-Kirkness Report*, para 14, pages 10–13.

[10] *Report of the Indian Railway Enquiry Committee*, 1937, para. 169, page 102.

[11](*a*) *Report of the Technical Sub-Committee, to the Subject Committee on Transport, on the Future of Road Transport and Road-Rail Relations*, November, 1943. New Delhi. Government of India Press.

(*b*) *Post-War Road Development in India—Proceedings of the Conference of Chief Engineers of Provinces and States*. Held at Nagpur from 15th to 18th December, 1943. Copies available from the Secretary, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi.

Government would, in addition to the most generous subventions possible for other roads, take over liability for the improvement, completion or new construction of a National Highway system amounting to about 20,000 miles, of which about three-fourths would be in British India. Provincial Governments were asked, for their part, to agree that they would pay special attention to the development of district and village roads; to the amendment of the Motor Vehicles Act, 1939, to make it a co-ordinating Act; to participation by Indian Government railways in road transport, mainly for passengers, in joint-stock concerns with existing operators; that they would, as it was proposed that the Act should provide, give such directions from time to time to the transport authorities as might be necessary to give effect to agreed policy for the regulation of motor transport, particularly in respect of long-distance goods transport; and that they would concede to the Central Government the final voice in the control of transport on National Highways.

Tripartite Plans

Stated briefly in general terms, Provinces agreed to the amendment of the Motor Vehicles Act and a Bill is now before the legislature. The majority agreed to the railways participating in road transport companies, but elected to take part of the shares themselves. The launching of a number of such tri-partite concerns was at the last minute shelved by the refusal of the Assembly to vote the necessary funds in the railway budget of the current fiscal year, but the question is still open. The majority did not accept the proposal that the centre should have a final say in control of traffic on National Highways, but agreed that they would ensure control of all road transport in accordance with the terms of a code to be drawn up and agreed. The final issue of these negotiations has not yet been announced. It is clearly dependent on the form of the new constitution.

The Road Fund had in 1945 been in existence for fifteen years, nine of peace and six of war. It continued during the war, but was applied to the construction and improvement of internal roads necessary to the prosecution of the war, for which also other very large sums were provided. As already stated, much construction and improvement of bridges, particularly in Madras and the Central Provinces, and considerable construction and improvement of surfaced roads, were financed from the fund, and otherwise, so that in the fifteen years 1930 to 1945 the mileage of surfaced roads increased from 57,000, mostly ordinary macadam, to 70,000, including 12,000 miles of modern surfaces, that is black-top of various sorts and cement concrete; an increase of 23 per cent. in fifteen years, together with the conversion of roughly the same proportion from macadam to more durable and dustless surfaces. In 1945 there were approximately 145,000 miles of earth roads in charge of the different public authorities, but still in very poor order, making a total of 215,000 miles of roads of all sorts. It may be noted here that the Nagpur Plan, which is the basis of the post-war ten-or fifteen-year plans, would add 70 per cent. to the mileage of surfaced roads, making a total of 120,000 miles; over 50 per cent. to the mileage of earth or other low cost improved roads, making a total of 210,000 miles; and, in the aggregate, increase the total mileage of all roads by 53 per cent. to 330,000. All these figures relate to extra-municipal roads in British

India. The date and speed of commencement were to depend on the movement of the general price index and on the labour market. In the meantime, efforts were being made to increase the strength of engineers, surveyors and draftsmen, to build up the construction plant required, and to deal with other preliminaries.

A development of great importance which resulted indirectly from the recommendations of the Jayakar Committee was the creation in 1934 of the Indian Roads Congress, a society with a somewhat unusual constitution adapted to the quasi-federal position in India and designed to promote interchange of ideas and experience, promote standardisation and advise on research. In essence it is a private association of the engineers employed on road work under the Central and Provincial Governments, the States and local bodies, with a leavening of engineers engaged in businesses connected with road construction and a few laymen closely connected in some way with its objects. Its membership includes a high proportion of those eligible, and, through annual meetings and more frequent meetings of the council and a number of committees, has done great work in, to use one of its, slogans, "improving the road-rupee ratio". Its revised book on bridge loading, design and construction practice, to give an outstanding example, which it is about to issue, is a very valuable work. Through the congress, the pooling of professional experience and the ventilation of progressive ideas are, it can be said, as complete as is humanly possible; and, largely through the efforts of its members, sure foundations have been laid for the efficient execution of the plans of the future. Future road research will be more active than in the past. The Central Road Research Station under the Council of Scientific and Industrial Research, will be firmly connected with actual practice by two-way traffic through the members of the Congress and its committees.

Motor Services

From the start with ramshackle motor vehicles after the last war, the business was largely in the hands of "small" men operating so near the margin of bankruptcy in a highly competitive field that substantial concerns could make little headway. I do not here allude to city bus services, of which the B.E.S.T. Company in Bombay is a shining example, although others are not so good. As in other matters, however, Madras has been an exception to the rule and two or three substantial concerns have come to the top, and provide safe and regular services in clean buses with efficient vehicle repair shops. Of these the most progressive is perhaps the firm of T. V. Sundaram Iyengar and Sons of Madura. The Nizam's Railway in Hyderabad also runs very efficient services, but the States are outside the scope of this paper. Elsewhere, the business remained in the hands of small men owning from one to five vehicles each. Here and there, notably in Ratnagiri and the Deccan district of Bombay, these formed fairly stable co-operative units; and, towards the end of the war, there was a series of mergers into joint stock companies; but until then the majority of the approximately 40,000 buses and lorries were operated by small owners. In the earlier stages the vehicles were dual-purpose, and, by removing seats, goods were often, at least in Northern India, carried in buses. For this and other reasons the same chassis was commonly used for both passenger and goods work, viz., a 160-inch wheelbase, three-ton nominal

capacity Chevrolet, Ford, Dodge and Bedford, etc. The formation of more substantial concerns will doubtless lead to specialisation in selection of vehicles.

TYPES OF ROADS

Cement-concrete trackways make use of the tracking propensities of bullock-carts with the minimum expenditure of the most durable material, cement concrete. The tracks are each 2 feet wide, laid to the "gauge" of the local cart. The bullocks like the concrete and keep to it, and the wheels follow. Cart traffic is tidal, to market in the morning and home in the evening, and crossing difficulties are more apparent than real. In any case the empty cart does no great harm to the ordinary earth

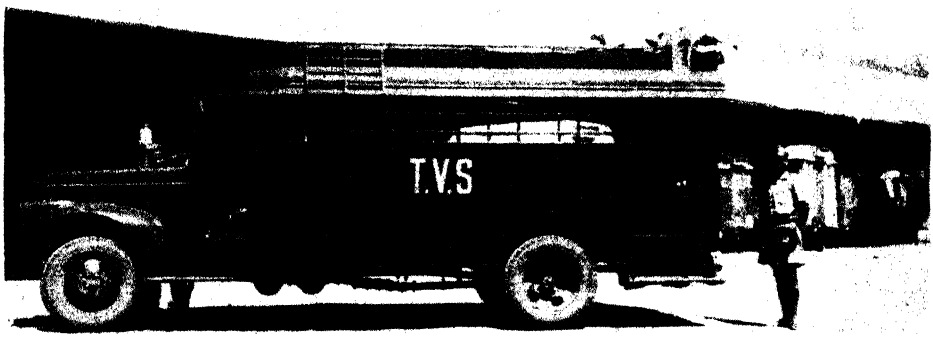


FIG. 2.—*Madura-Madras Presidency—A "T.V.S." country bus on 160-inch wheel-base, Chevrolet chassis. No windows are necessary in the warm climate. Conductors and drivers wear uniform*

surface which, relieved of loaded cart traffic, can be maintained as an ordinary earth road, suitable for other traffic, including light motor buses and lorries. It is true that the motor driver tends to think that the tracks are intended for him and to dispute the road with the cart, but that will be cured in time. The thickness of the concrete depends on local conditions of traffic and soil. As a general rule, a thickness of 6 inches is adequate on alluvial soil, but thinner slabs over stabilized soil or other foundations are used if more economical. Some technical difficulties have been experienced through expansion and "creep", but these, also will doubtless be overcome. "Trackways" have been laid in many places about the country and will, I believe, play a large part in future development of low-cost roads.

The types of surface of major district roads and Provincial and National Highways

depend more upon traffic and climatic conditions and on what at present exists than on the administrative classification. Subject to any limitations imposed by available capital, materials, plant and supervisory staff, the engineer will apply the test of lowest possible ultimate cost, taking interest and amortization of capital and recurring maintenance costs over, say, twenty years, and using cement concrete, tar and bituminous mixtures, or "paint-coats", or a combination of them, accordingly. As stated, there are now 12,000 miles of modern surfaces in existence from which to judge. Cement concrete gives probably the most durable dual-purpose surface and much work has been done, particularly in the United Provinces, in the evolution of thin concrete slabs laid on old macadam, particularly of *Kankar*, and slabs as thin as 3 inches have been satisfactory. Tar and

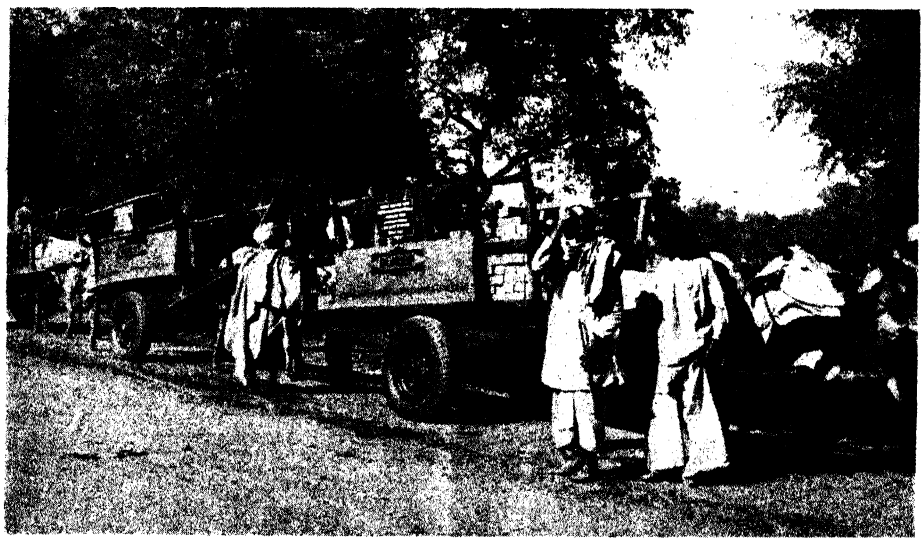


FIG. 3.—*Pneumatic-tyred Bullock carts.—Modern bearings reduce tractive effort and increase capacity per pair of bullocks*

bitumen have been used in practically every known specification, according to circumstances. Although dense asphaltic concretes withstand very heavy mixed traffic, "black top" surfaces are by nature plastic, the slight indentation caused by one set of wheels being "ironed out" by the next, and so on; and with tracking bullock carts "ironing out" does not occur. This, particularly where the range of temperature is great, has to be guarded against. Light, and very light "paint-coats" of tar and bitumen have been very successful, offering no appreciable thickness to yield to the cart wheels. The lightly tar-dressed macadam roads of the Punjab are an outstanding example. Here the prevalence of wooden-felloed carts is partly the reason.

Where the total density of traffic requires or justifies widening the hard-surfaced carriageway it is now usual to provide the extra width in one or two cement concrete haunches, say 8 feet wide, for carts, the centre being left as "black top" of some sort. The bullocks prefer the concrete and the colour contrast assists segregation.

Where circumstances and finance permit, complete segregation of cartway and fast traffic road, separated by a ditch or trees, is ideal. Each roadway can then be designed to carry its own traffic. Paradoxically cement concrete might be provided for the carts and as the first stage for the motor road even dry brick trackways might, if necessary suffice. But, since duplication of bridges and culverts would be expensive, the possibilities of complete segregation are limited.

No paper on roads in India would be complete without mention of the humble bicycle which, in astronomical numbers, is a means of transport as much as a private conveyance. Delhi's daily milk supply comes in mainly on bicycles festooned with cans; and it is quite common to carry a passenger. At least on the main road

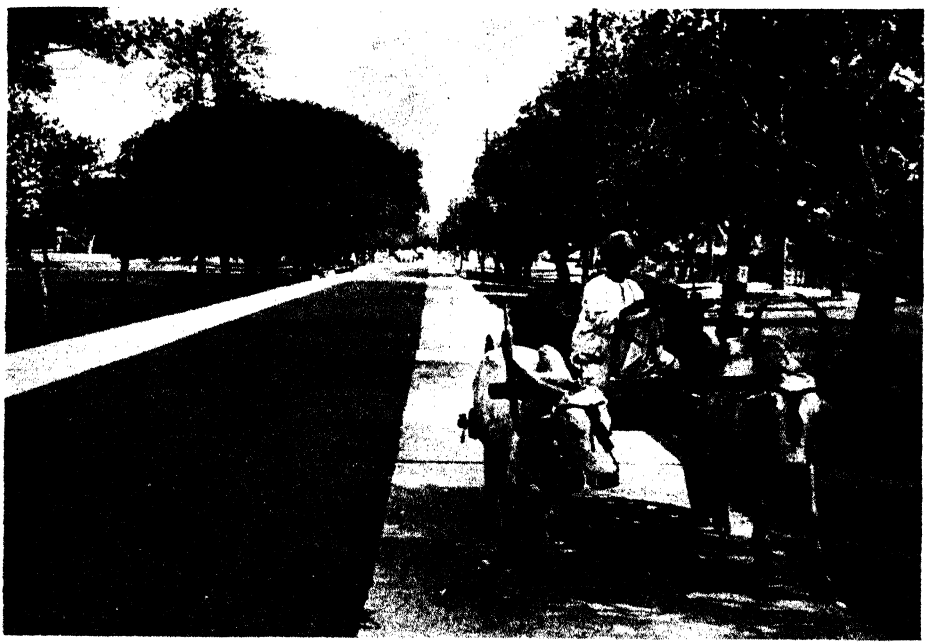


FIG. 4.—*Bombay-Poona Road.—Concrete haunches and "Black-Top" centre*

approaches to towns, separate cycle tracks will have to be a standard part of road lay-out.

On the new road approach to the Howrah bridge and Calcutta; three National Highways from Delhi, Bombay and Madras will converge. On it will appear heavy lorries from Tatanagar and other centres of industry, passenger buses, long-distance cars, a host of local motor traffic, carts, cycles, rickshaws and foot people in the numbers that only Calcutta can produce. It will, it is hoped, be laid out with every regard to safety and convenience that modern traffic science can devise. It should be a remarkable highway.

I have already exceeded my allotted space, but I am conscious of many omissions. For instance, the part played by motor transport in the war; petrol rationing and the organisation and research that went to the conversion of over 20,000 vehicles to producer gas, saving in that way alone between twenty-five and thirty million gallons

of petrol a year; the roads built for war needs and the wear and tear of war on roads; more about future plans, such as the national highway routes; projects for major bridges on them; the new research station and organisation; the requirements of road construction plant; and questions of engineer man-power. All these and more have had to be either omitted or barely touched. But I must conclude.

I am indebted to the Concrete Association of India for some of the road and bridge photographs and to Mr. T. S. Krishna, of Messrs. T. V. Sundaram Iyengar and Sons, of Madura, for the picture of that firm's vehicles and premises. I trust that the illustrations will to some extent have supplied omissions in the paper, particularly in respect of modern developments, and will have dispelled any impression unintentionally conveyed in the text of continuing stagnation in the bullock-cart era. Nothing could be further from the truth. Thanks to the work of the Indian Roads Congress and the efforts of such bodies as the Indian Roads and Transport Development Association, the urgent need for more and better roads is generally accepted, and the ways and means to make them are known. The at present small but devoted band of road engineers, also, is ready for the task that lies ahead.

If I have stressed the problems of the minor road and of the bullock-cart, it is because, rightly or wrongly, I believe that the crux of the matter lies in the minor roads. It is the minor roads that have been most neglected in the past and will be in danger of further neglect if development is too much from the trunks outwards. It is the minor roads that condition the whole business of rural marketing and the material and social progress of the farmer. It is by way of the minor roads that all schemes for rural uplift and betterment will reach their target, or fail to do so; and it is on the improved minor road that must come the reform of the bullock-cart and the consequent reduction in the cost of all roads. All is ready for a great advance, and awaits only the early establishment of a stable Constitution, for which we all hope.

DISCUSSION

Sir HENRY KNIGHT: I very greatly appreciate the opportunity of being here to-day and even more the opportunity you have given me of speaking, especially as very nearly twenty years ago Sir Kenneth Mitchell was the Technical Adviser to the Government of India Road Committee and I was the Secretary to that Committee. We had a most interesting time, including a tour all round India, arguing with representatives and officials and doing what might be called propaganda work for better roads in India. Thereafter Sir Kenneth "took the highways", and I took the low ways back to Bombay, and I have had little to do with roads since.

However, the many years I spent in India have shown me the very great difference good road transport has made to the villager. When I first went to India a villager involved in a law suit might have to make a journey to a place twenty miles away which was one-and-a-half days each way in a bullock cart, and the same difficulty arose when he wanted to market his crops. He can now often get there and back in the day by the motor bus and motor lorry.

I fully appreciate the very great difficulty of combining a road surface for motor transport and bullock cart, although I think I am right in saying that the bullock-cart problem is perhaps partly our own fault, because the bullock cart with the narrow iron tyre used in the Deccan was designed a hundred years ago by an officer of the Royal

Engineers. If he had only provided for wider tyres perhaps our problem would not have arisen!

I hope that the Government of India will press on with the National Highways, and I noticed an interesting reference to this matter in the Finance Member's Budget speech in the Legislative Assembly. He said: "One important development, which deserves specific mention, is the assumption of financial responsibility for the construction and maintenance of National Highways from 1st April, 1947, and a total provision of about Rs.6½ crores for national highways expenditure during 1947–48, Rs.2¼ crores in the Revenue Budget and the balance in the Capital Budget, has been made." I trust, therefore, that we shall see real progress in the National Highways and equal progress in the Provincial Highways.

I speak with some feeling about National Highways, because about three months ago it was my fortune to travel over the "Indo-Burma Road", a road which was modernised during the war. When I made the journey the road was rapidly deteriorating and heavy slides had taken place on the way to Imphal. I could not get to the Burma frontier at Tamu because the road had completely given way at one point, and although a Heath Robinson sort of bridge had been placed there for Burma black-market traffic, I did not dare take my car over it!

It is to be hoped that the Government of India will spend an adequate proportion of the money allocated in the budget in putting the Indo-Burma highway into good order. In that connection I might conclude by quoting the following piece of doggerel:

" I wish the Indo-Burma
Road were firmer.
One might almost say,
It is the only way"—

and that is over the Khud.

Mr. EDWARD FRYER: I have enjoyed this afternoon very much, although I have never been to India. I am impressed by the lecturer's remarks with regard to the "paralleling" of main-line railways and trunk roads. That has been almost a fetish with us for a number of years, and was advocated in the Report of the Select Committee of the House of Lords—one of the most far-reaching examinations we ever had in connection with British roads. I am entirely with the lecturer in his advocacy of road and railways not being in competition.

I should be interested to know if the lecturer could give any idea of the average mileage per car in India and the sort of distance it might do on one particular journey, and could say something about speed.

Lieut.-Colonel E. W. SLAUGHTER, C.B.E., M.I.M.E., M.INST.T.: The lecturer, with whom for some years I have had the privilege of discussing many problems of road transport and road development, has given us this afternoon a very good historical background to the development of transport in India. He has brought out the important factor that it was not until about 1932, when pressure drove the Government of India by way of reduced earnings of the railways, that they took up the question of the proper development of road transport seriously.

At that time the Nizam's State Railways were in a much better position than the Government of India to tackle the problem on their own basis, and subsequent events have shown clearly the advantages of having the ownership of both railways and roads under one authority.

We took at the time what has since proved to be a very realistic view of the co-ordination of road and rail. I was fortunate enough to have a mission from the Government which took me to Europe in 1933 to study this problem, and I came back convinced, as a railway man, that there was only one way to bring about a proper form of cheap transport—namely, the co-ordination of both services.

In Hyderabad we built up a good road and rail co-ordinated service, and to-day it has something like 600 vehicles on the road with a route mileage of some 4,500. Last

year about twenty-two million passengers were carried by road. The public is now getting a fairly good service. We have not been able to extend the road mileage and the number of services to what we should like, owing to the fact that we were not able to get new stock; but it does show that in Hyderabad the control of road and rail by one authority led to considerable development on right lines. At the present time we have on order some 350 vehicles, double and single-deck buses, with fifty-four seats on the double-deckers and thirty-five seats on the single-deckers, at a cost of some one million pounds. They have Diesel engine chassis and well-designed metal bodies, of the same standard that has served us so well in the past. The light American type of chassis would not have seen us through the stress and strain of war conditions, and we have come to the conclusion that as a matter of pure economics it is better to have a first-class vehicle in the first place rather than a lighter one, which is not designed as a passenger vehicle and which usually causes maintenance troubles. That is an important factor overseas, and one of the differences I had with the lecturer during the latter part of the war was that he was obliged to force upon us lease-lend vehicles which gave a great deal of trouble. He also insisted that we took gas-producing plant for these vehicles, which in turn brought about a chain of maintenance difficulties. The maintenance costs of these lighter vehicles doing heavy and regular work indicate that it is preferable to have the heavier type of chassis with the first-class body.

I have with me a few statistics which might be of interest. The running cost of the gas vehicle is 2.93*d.* per mile, of the petrol vehicle 3.74*d.* per mile, and of the diesel engine .43*d.* per mile. I should add that the additional cost of maintenance of the gas-producer plant vehicle is very much heavier than that of the petrol-driven vehicle and the arrangement is not so reliable. Our earnings per bus mile are about 15*d.*, and operating and maintenance cost run out at about 12.7*d.* It may also interest you to know that in our organisation 95 per cent. of the trips were run to time, and that out of 70,000 scheduled connections with trains we maintained 99.3 per cent., which was, in our opinion, very satisfactory in the circumstances.

The lecturer has referred to the war effort, in which road transport played an important part in India. We took the opportunity to mobilize special mobile units to prepare for emergencies. They were self-contained fleets of sixteen vehicles each and were directed to particular districts where stocks of grain had accumulated, dealing with these food supplies in bulk to the nearest railhead. As an emergency measure under famine conditions it was a very good effort, particularly where it enabled blocks trains to be made up on the railways. In the last year of the war these eight mobile units moved some 350,000 tons of food grain to railheads with fairly long leads and not too good roads.

I mention this to show the value of having a co-ordinated road and rail organisation at your disposal where one has to legislate for war, floods, drought and famine conditions.

Mr. A. V. PARNACOTT: When considering this subject we must bear in mind the enormous area of India. We must also bear in mind the differences in the populations, particularly between the north and south. Again, we must remember that some of the early inhabitants of India apparently used fire to crack the granite rocks and so on rather than rock drills. It does seem to me that that is a method by which road and rail interests can get the small stone ballast for the purpose of road and rail making. Then I should say that the climate of India is such that with the large water areas it should be possible to grow—I emphasise the word "grow"—the so-called petrol for vehicles and even for locomotives.

I was an old friend of Colonel Crumpton and we used to discuss at length the Indian vehicles with their large diameter wheels. Those large wheels are, of course, for the purpose of trying to help the bullocks pull the vehicle over very bad ground, but the higher the load is carried above the road surface the greater is the rocking and destruction of the road. It seems to me to be a great mistake to overlook the fact that wheels can be multiple and smaller in diameter.

If I were younger and if I were trying to co-ordinate the railways and the roads, I should construct the vehicles so that they could run both on the rails and on the roads and, at the same time, make them amphibious.

Lieut.-Colonel E. W. SLAUGHTER: If the last speaker is referring to vegetable oil as a home-grown fuel, I think it is true to say that every bit of ground-nut oil which is grown in India to-day is wanted for food. It is a fact that the export of ground-nut oil has almost been banned in India.

THE CHAIRMAN: I should like, on behalf of all of us, to thank Sir Kenneth Mitchell for his extremely interesting lecture. I have from time to time made many applications to Sir Kenneth, when he was Consulting Engineer for Roads to the Government of India, for grants in aid of road and bridging schemes in several Indian States, and I must say how very interesting and helpful I always found his observations and comments upon the plans put to him. I, and I am sure all of us here, can now realise all the difficulties which confronted him in deciding what schemes should have preference over others. I should like to express my thanks to him for always being so helpful, and once again to thank him for his very interesting address to us this afternoon.

The vote of thanks was accorded with acclamation and the meeting concluded with a vote of thanks being accorded to the Chairman by Lieut.-General Sir THOMAS HUTTON.

Sir FRANK NOYCE writes: It was a matter of deep regret to me that the chaotic road-rail conditions prevented my fulfilling the promise I had made to Sir Kenneth Mitchell, before I knew of what an English winter was really capable, that I would preside at his lecture whatever the weather. I was specially sorry not to be present, as no one is in a better position than I am to testify to the outstanding part Sir Kenneth has played in the development of roads in India. For the five years from 1932 to 1937 during which I was Industries and Labour Member of the Government of India, we worked in the closest association. He had been Road Engineer to the Government of India since 1930, the year which saw the creation of the Central Road Fund, the administration of which was already presenting problems, on which the Central and Provincial Governments held conflicting views. The effects of the rapid development of motor transport on railway revenues were beginning to cause the Government of India considerable anxiety, and one of my first duties after I became a Member of the Government was to convene a Conference of all the interests concerned, Central, Provincial, Railway, Road and Inland Navigation. The Conference met in Simla in April, 1933, and was attended by sixty-five representatives. It achieved quite a considerable measure of agreement and nothing contributed more to its success than the thorough way in which its Chairman was briefed by Sir Kenneth. I remember that Lord Willingdon, in opening it, described the road-rail problem as one of the growing pains of civilisation, and went on to say that in India it was comparatively new and its difficulties less developed. He thought that this meant that India had an opportunity for timely adjustment which many countries had not had and was, therefore, in a position to profit by their experiences. The problem in India may have been new, but it was by no means easy for, in India, there is the great difficulty presented by the divergent interests of the Government of India which has to bear in mind the 600 to 800 crores of the taxpayers' rupees invested in the railways, and those of the Provinces which naturally put roads first. The outcome of the Road-Rail Conference was the creation or reorganisation of Boards of Communications in the Provinces and the establishment of the Transport Advisory Council over two meetings of which I presided, that of 1935, by which time Sir Kenneth had become Consulting Engineer to the Government of India (Roads), and that of 1936. I think Sir Kenneth will bear me out when I say that the first meeting was more harmonious than the second. Stresses and strains were becoming increasingly apparent, the main point of difference being, as was to be expected, the extent of the Government of India's control over the application of the Central Road Fund. Sir Kenneth's most interesting paper, which deals in concise and lucid fashion with an extremely compli-

cated subject, shows that those stresses and strains still continue—they may well become far more marked under the new constitution—and there must have been many occasions, since I left India in 1937, when the Government of India have had reason to envy the happy state of affairs in Hyderabad, where railways and roads are under one authority and it has, therefore, been possible to establish a completely co-ordinated system of road and rail transport with results so well brought out by Colonel Slaughter.

If I had been present at the meeting I should have put one question to Sir Kenneth. Shortly after I left India, roads and railways were consolidated in a "Communications" portfolio. I admit that that seems the more logical arrangement, but I have often wondered whether there were not some advantages in having roads and railways in separate portfolios as it enabled the Member in charge of roads (and, incidentally, in charge of many other things) to view road and rail competition from a rather more detached standpoint than his colleague the Railway Member. Sir Kenneth had experience of both systems and his opinion on the subject would be of great interest.

There is one point I may perhaps mention in conclusion. During the five years I was its Chairman, there was never the smallest disagreement in the Standing Committee on Roads, though its members were drawn from all parties in the Central Legislature and the majority of them certainly did not see eye to eye with the Government on all subjects. That harmony was not due to any merits in its Chairman, but to Sir Kenneth's persuasive powers and the reasonableness with which he always stated his case.

Sir KENNETH MITCHELL writes: The reading of the paper took up more of the time of the meeting than it should have done. I am therefore taking the opportunity of writing a reply to the communicated comments of Sir Frank Noyce after seeing the transcriptions of the various speeches and questions.

I entirely agree with Sir Henry Knight regarding the great advantage to the villager of being able to visit, say, the district courts and return home the same day, instead of having to be away from home for perhaps three days if the journey is by bullock cart; and in the paper I attempted to stress the need for a complete system of roads to bring this benefit, and many others, to the whole countryside. At present it is confined to relatively few villages or areas many of which have also a railway, while others have neither railway nor adequate road. As regards the bullock-cart wheel, the introducer of the steel tyre cannot be blamed. That type of wheel was, for its day, an advance on its predecessor. The wooden-felloed wheel is too heavy for any except the flattest country and the hardest wood too soft for Deccan trap and other hard stone metal. The failure came later in the omission, by education and regulation, to check the insidious narrowing of the tyre and increase of loads. I had not seen the budget speech quoted by Sir Henry, and it is heartening to know that the interim Government is immediately going forward with the National Highways scheme. I may add that, since the paper was read, I have heard that the Assembly has now approved the scheme of railways participating in road transport, and has voted the necessary capital for investment in the joint or tripartite concerns. Thus, in these two important respects, the plans are being put into effect. As regards the Assam-Manipur-Burma road, I fear that considerable realignment will be necessary. Before the war, there had for years been troublesome recurring landslides on the road that then existed from Dimapur or Manipur Road Railway Station to Imphal, and the country beyond is liable to the same defects. At the time of the advance into Burma the road had to be extended under the urgency of *aut viam faciam aut inveniam* (the motto of one of the old Sikh Pioneer Regiments), and while the line found and the road made was topographically sound, the geology, at least beyond Palel, is unsound and much of the road will have to be re-aligned and rebuilt.

I did not wholly follow Mr. Fryers' reference to parallel roads and railways in Britain, and the House of Lords report. Conditions as to scale of distances and intensity of railways and roads are, of course, very different. As I stated in the paper, it is inevitable and proper that there should be alternative road means of communication between places connected by railway—in any reasonably complete road and rail system. The point stressed in the paper was, as stated above, the lack of balance in the Indian

systems. It may help to clarify the difference between the conditions of the two countries to emphasise that the advent of motor vehicles in Britain found all roads metalled and brought about the improvement of all roads—in respect of surface. The same event in India found only a fraction of the total mileage suitable for motor transport (and a considerable part of that duplicating railways), and for a time concentrated improvement on those roads. As to average car mileages, distances of individual journeys and speeds, no statistics are available and I can only give my personal impressions. The daily or monthly mileage run by a car depends on the purposes for which it is used, the number in the family and so forth; and I can only say that (temporary petrol rationing apart) probably no one keeps a car unless he has need to use it for 500 miles in a month at least, and that relatively few have occasion to do more than 1,500 miles a month. Distances travelled on individual journeys, again, are a matter purely of personal circumstances. In Northern India, where roads are good, 300 miles in a day is quite common. I myself, when in something of a hurry, once drove from Poona to Delhi, about 900 miles by the Rajputana route, in two and a half days. Apart from local restrictions, there is no legal speed limit for cars, but the vagaries of cyclists and bullock carts, the danger of a front wheel puncture or burst from a bullock-shoe and the possibility of treacherous soft spots in the earth shoulders make it generally unwise to drive faster than fifty miles per hour. Personally, I used to time my tours so as not to have to exceed forty.

Before referring to Colonel Slaughter's remarks it is as well to clear up a point of nomenclature, which is that, to avoid confusion with railways owned by certain Indian States, *e.g.*, Hyderabad, Mysore, Baroda and Jaipur—the " nationalized " railways are now called "Indian Government Railways" and not "Indian State Railways". As emphasised by Colonel Slaughter, and underlined by Sir Frank Noyce, the State of Hyderabad is fortunately placed *vis-à-vis* transport co-ordination. With the exception of a length of an Indian Government Railway, aligned generally transversely to the main road system (part of the Sholapur-Gunthakel section of the G.I.P. south-east main line), the railways in the State are owned and operated by the State and therefore road and rail questions can be decided by the unitary Government of the State. One result has been the early institution of a virtual monopoly of the road services on certain routes operated by the State Railway Administration in conjunction with railway services. A safe, regular and reliable road service is the result. It is also noteworthy that, over-all economy being more important than first cost, British vehicles are used. The temporary need to use North American vehicles obtained on lease-lend or Canadian mutual aid was of course dictated by global supply policy during the war, and was nothing to do with me personally, as Colonel Slaughter, doubtless unintentionally, appeared to imply. As regards producer-gas, the war is over and I have no desire to reopen that minor internal strife. I may say however that it was not the War Transport Department, but " enemy action " and the imperative need to save petrol, that "forced" Colonel Slaughter to use producer gas, or suspend road services. We were, at times, very unpopular, but are quite unrepentant and indeed proud of the achievement of having during the most critical years of the war, in India, saved twenty-five to thirty million gallons of petrol a year in this way.

Turning to Mr. Parnacott's remarks, I have to confess to ignorance of the matter of stone-breaking by heat and as to the type of motor and locomotive fuel which could be "home-grown". I am therefore unable to comment on those points. As regards multiple small-diameter wheels—presumably for carts—I suggest that the smaller the wheel the greater the rolling and axle-friction resistance and also the pressure on the road. In any case you cannot usefully have more than two axles on an unsprung rigid-framed vehicle; and since with pneumatic tyres and modern axles you can carry a full load for a pair of bullocks on two wheels, I doubt if any useful purpose would be served by having more. As to the convertible rail or road vehicle, I thought that that somewhat unnatural mechanical contraption had given place to transferable containers for the particular purpose in view. Transport of additional deadweight in the tare of dual purpose vehicles

was I believe found to be unduly expensive. The same objection applies to amphibians for which over the greater part of the area of India there would be no particular object.

I am grateful to Sir Frank Noyce for his kindly references to my personal part in these matters. As to Lord Hillingdon's hopes, quoted by Sir Frank, I believe that while at times the negotiations seemed to be interminably protracted, India has still grasped the nettle in good time and has now laid the foundations of an effective scheme of co-ordination. Stresses will continue to be manifest from time to time, and railway and financial magnates show symptoms of a recurrence of the disease of "*hodophobia*". I feel reasonably certain, however, that, given stable conditions, any temporary maladjustments that occasionally appear will be absorbed in the growing demand for transport of all sorts that a progressive India may expect. With reference to Sir Frank's specific question as to the efficacy of the merging of the responsibility of road and rail in one Member of Government, I must state my conviction that this has been a great success in practice. The practical difficulties in the way of a consistent and progressive administration of the two lie not so much in the determination of general policy, which is in any case a cabinet matter, but in the translation of that policy into decisions on specific issues as they arise. Where an agreed decision cannot be reached between the heads of the two departments it is better that the final voice should lie with a single member of the Government in close daily touch with the two aspects of the general problem than that they should become an issue between two members of Government both more than fully preoccupied with their own subjects and neither with a full appreciation of the other aspect. In the nature of things the "give and take" of practical argument is then liable to lead to illogical and inconsistent compromises. The present difficulty in the matter of administration seems to me to arise rather from some blurring of the dividing lines between the separate and very distinct functions of Government in relation to nationalized transport, and particularly railways. The first function is to promote the necessary legislation and in its administration to guard against the dangers of too powerful monopolies and to hold the scales even between the railways, the public using the railways and other forms of transport. The second function is to see that the railways are operated as efficiently and profitably as possible. Nationalization of railways does not in itself dispense with the need for the proper discharge of the first function, and when the second falls to an ordinary Department of Government, there may be genuine conflict of interest between the two. The "blurring" to which I have referred will possibly continue in India until the establishment of the Federal Railway Authority or something on that model to relieve the departmental Government of much if not all of the second function.

FLAX UTILISATION

By A. J. TURNER, M.A., D.SC.

Director of Research, Linen Industry Research Association

Sixteenth Ordinary Meeting, Wednesday, March 26th, 1947

Mr. ERNEST W. GOODALE, C.B.E., M.C., *in the Chair*

THE CHAIRMAN: Dr. Turner, who is going to talk to us this afternoon on Flax Utilisation is, as most of you know, the Director of the Linen Industry Research Association at Lambeg in Northern Ireland, and I do not know anybody more qualified to speak to us on anything to do with flax or linen either in its raw, its yarn, or its fabric state.

Dr. Turner is also a member of long standing of the Textile Institute. He is at present a member of the Council of that body and a member of several of its committees. He has had previous experience in research at the Cotton Industry Research Association at the Shirley Institute, Manchester. He is also this year the Upper Warden of the

Worshipful Company of Weavers, which is the oldest of the City Livery Companies in London.

Those are his qualifications, and as I say, no one is better qualified to talk to us about linen, so without further introduction I will ask Dr. Turner to give us his paper.

Dr. TURNER then read the following paper:

Flax utilisation offers us a subject for the study of textile diversity. The widespread utilisation of flax in a wide variety of fabrics is an expression of the diverse properties of the flax fibre. Whatever types of flax are used, whatever grades, and whatever combinations of fibres as yarns or fabrics—these special properties of the flax fibre assert themselves, and confer upon the material a character that is all its own. Why is it, we may ask, that the flax fibre was held in such high esteem in ancient times, finding favour in the eyes of sovereigns and of the priesthood, particularly for use on all ceremonial occasions? Why, too, has it found several uses of a much more homely kind for the table and the bedroom—besides outdoor uses for sails, fishing lines, and nets? What is the reason that this high regard for linen has persisted through the ages, and endured right up to the present time? The answers to these questions lie in the nature of the flax fibre. I propose, therefore, this evening to give you some account of what the flax fibre is and what its properties are, and to trace the connection between these properties and the utilisation of flax.

THE FLAX FIBRE

Flax fibres are the bast fibres of the stem of the flax plant. The plant is an annual one, and its stem when grown for the sake of the fibre attains a height of three to four feet, with a head of short branches which bear the flowers and subsequently the seed bolls. Each plant is grown with a single stem, hollow when mature, and about one-eighth of an inch in diameter. As seen in a cross-section of the stem, the flax fibres occur in about thirty bundles, each containing about thirty fibres, arranged in a ring just under the surface of the stem. The bundles extend from the bottom of the stem to the top; but the individual fibres are only just over an inch long and overlap one another, though the number of fibres in the bundle cross-section remains about the same throughout the whole length of the stem. These bundles of fibres are surrounded by a network of soft cortical cells, which are themselves bounded on the outside by the epidermis and on the inside by the woody part of the plant.

Each ultimate flax fibre is polygonal or roughly circular in shape, about one thousandth of an inch in diameter, with a small central cavity or lumen; the ends of the fibre taper to solid points. The solid matter inside the fibre is largely cellulosic in composition, and has a highly complicated structure. This structure consists of concentric lamellæ, which, in turn, are composed of fine strands known as fibrils. When an ultimate fibre is swollen by suitable treatment, the fibrils can be distinguished under the microscope; there are about one million fibrils per fibre. Recent investigations by the electron microscope have shown that one of these fibrils can split up into still more "elementary fibrils", so that there are about 36 million of these elementary fibrils per ultimate fibre.

EXTRACTING FLAX FROM THE PLANT

The first problem in the way of flax utilisation which is presented by the flax

stems is that of extracting the flax fibres from among the other tissues of the stem in which they are embedded. This problem is no easy one. By means of the LINRA Flax Analyser—an instrument invented a few years ago in the Research Institute of the Linen Industry Research Association, it can be shown that about 25 per cent. of the average flax stem consists of flax fibres. The difficulty is to find an extraction process that will recover all this flax fibre without depreciating its quality. The commonest processes have quite a long history behind them, but though many processes have been tried, in some way or another all are wanting.

Green or Natural flax.—The most recent process has the advantage of simplicity, but unfortunately suffers from a number of disadvantages; in essence, the process consists of first removing the seed, passing the deseeded stems through weighted rollers to break the woody part, and then stripping the broken wood from the fibre in a turbine scutcher—a heavily built machine developed in recent years that alone makes the job feasible. In this process there is a considerable loss of fibre, and although exceptional yields are obtained at times, the average yield of fibre of a number of crops seldom exceeds 10 to 15 per cent. on the deseeded straw. Moreover, great difficulty is experienced in completely removing the woody tissue, so that a certain percentage remains adhering to the fibre. Also, in its subsequent processing in the spinning mill this "green flax" is not easy to handle, and gives rise to a considerable amount of dust, as well as a higher percentage of loss in processing than is experienced with flax produced by the older forms of processing. For these reasons green flax is not very popular with flax spinners.

Retted flax.—The time-honoured method of extracting the flax fibre from the stems has involved the use of water in some form or another. Reference has already been made to the strong adherence of the neighbouring tissues to the bundles of flax fibres. The tissues are, in fact, strongly gummed together by pectin. The mechanical method of extraction aims at breaking down the cortical tissue surrounding the flax fibres; the alternative method using water depends upon the action of bacteria or moulds that feed upon and consume the pectin, thereby weakening the adherence of the flax fibre bundles to the surrounding tissues, thus making the subsequent scutching operation a comparatively light one, and yielding very clean fibre.

The straw is completely immersed in water in some processes (water retting) but sometimes it is only soaked intermittently by dews (dew retting). In the water ret, rapidly multiplying anærobic bacteria quickly get to work on the pectin softened by the water, whilst in the dew ret the active agents are moulds working under ærobic conditions. Retting by water may be in natural or artificial ponds or dams, slow running streams, or in large concrete tanks, either open or closed. The duration of the retting action depends to a large extent on the temperature, being generally complete in about three days at a temperature of 30° C., and taking as long as seven to twelve days or more at ordinary atmospheric temperatures. The closed concrete tanks of the Belgian model, introduced within comparatively recent times, have been successful in producing the highest qualities of flax (Courtrai). Such tanks give rise to an effluent problem in some districts, as a four tank rettery may require to discharge as much as 100,000 gallons of highly noxious flax water effluent per week. To overcome this difficulty during the recent war years, the Water Pollution Board

devised an aerated ret which obviated the necessity for the discharge of so large a volume of effluent.

Briefly, then, the different types of ret are as follows :—

River

Tank — Open — Belgian
Tank — Open — Aerated
Tank — Closed — Duplex
Tank — Closed — Interrupted

Dam

Dew

Chemical

FLAX FIBRE QUALITY

With such diverse methods of extracting the flax fibre it is not surprising that wide variations are encountered in fibre quality. But quality does not depend on the extraction processes only; it depends also on the type of flax, the conditions of its growth and harvesting, and the way in which it is handled from the time it matures until it is finally scutched. This matter of handling is perhaps the most difficult one that the flax farmer has to face. Bad handling leads to lower yields and poorer quality of fibre.

Research to improve the yield and quality of the fibre extracted from flax stems has been greatly handicapped by the lack of objective methods of judging quality. Trade judgments are highly subjective; moreover different buyers may put different values on the same flax merely because they wish to use the flax for different types of yarns. For these reasons technical investigations have been undertaken in order to correlate fibre properties with actual technical performance, of which spinning value is the commonly accepted criterion. While this spinning test method at first sight appears simple and very advantageous, in actual fact it is by no means devoid of complexities and some degree of subjectivity, but it remains the best method yet available.

Differences in Flax growing countries.—I have referred to differences in the types of flax grown. Certainly there are notable differences in flaxes grown in different countries or districts, *e.g.* :—

Belgian (Courtrai); Russian (Ralo); Latvian; Dutch; Irish (Coleraine); Australian; Egyptian.

These fibre differences are the ultimate consequence of differences in soil, climate, seed, cultivations, and handling.

One of the most important features of good handling is that the flax stems are maintained throughout any process in a parallel condition free from initial entanglements, and with their root ends butted to a common level. The beet or bundle of flax straws is thus maintained in a trim, tidy condition, with an overall length equal to that of the longest straw. Badly handled flax is not butted in this way, and the beets accordingly get into bad shape and may have an overall length of nearly double that of the individual straws. Such beets suffer considerable losses in scutching. Straws that fail to produce flax on the scutching machine are not entirely lost. Waste from this machine is subjected to a second scutching operation to yield what is called re-scutched tow, consisting of short entangled flax strands.

Line and tow.—The useful products of the operations in the flax (scutching) mill are thus known as flax (the parallel and most valuable fibre), and re-scutched tow (the short entangled strands). In the subsequent processing of the flax in the spinning mill, the first operation is a kind of combing known as "hackling", by which the strands are completely disentangled and reduced to finer strands or "line". A certain amount of fibre breakage occurs in the process, and short fibres are removed as "machine tow", which amounts to about 20 per cent. in good grades of flax, but may rise to 50 per cent. or more in very low grades. Thus the flax fibre of the flax plant gives three types of raw material for the spinner:—

(i) line;
(ii) machine tow;
(iii) re-scutched tow.

All these are of commercial value so the complete evaluation of a new process of flax production, such as a new retting process, must include a determination of the amounts and values of each of these products in the subsequent operations.

Wet spinning and dry spinning.—There is a further complication in this matter of evaluating a process, *viz.*, the existence of two common methods of spinning—wet spinning and dry spinning; in the United Kingdom, the former is practised chiefly in Northern Ireland and the latter in Scotland. As a general rule, it may be said that wet spinning is used for fine yarns, and dry spinning for coarse yarns. Expressed in counts of leas (the number of leas, 300 yards long, in 1 lb. of yarn), the wet spun yarns range from 200 to 8 leas and the dry spun from 19 to 3 leas. There is thus some overlap in the range, but it should be remembered that there is considerable difference in the character of the two types of yarn.

Warp and wet flaxes.—Finally, the question arises for the spinner, for what class of weaving yarn, or thread, is the flax suitable? If it is of a soft nature, dividing easily, it is best used as weft, and if very strong and "bony", as thread; between these two extremes come a number of other types—prime warp, medium warp, damask warp, cambric warp.

We can now sum up the position of flax utilisation as from the spinner's point of view. He is either a wet spinner or a dry spinner within a certain range—equipped with plant for spinning both line and tow yarns. As he surveys a parcel of flax he must have in mind what percentage of the more valuable line it is likely to yield on hackling, and what quality of line it will give in relation to the particular sorts of yarn he spins. Cleanliness, wastiness, and quality, all have to be taken into account, and then the judgment finally made—the judgment that decides whether the destiny of the flax is to be in sheers, shoe-threads, or ship's canvas, or any other of the many possible outlets for the flax.

What a lesson in diversification is thus provided by the flax fibre as we contemplate the many sorts of fibre, the many types of yarns that can be made from them, and the innumerable types of cloth into which these yarns can be woven.

Flax Fibre Characters

It is fibre quality that is the outstanding determiner of fibre destiny. But first let us look at the fibre *properties that distinguish flax from other textile fibres.* The chief fibre properties of general importance are usually acknowledged to be:—

(1) length;
(2) fineness;
(3) strength;
(4) elasticity;
(5) flexibility;
(6) surface friction;
(7) lustre;
(8) dye-absorptive capacity;
(9) resistance to acids, alkalis, and oxidising agents;
(10) resistance to moulds and bacteria.

Of these properties the most important are the first three—length, fineness, and strength. For the purposes of yarn-making, some of the other properties—flexibility and surface friction—are related to "the big three", and deficiencies in them may be compensated to some extent by special values of length and fineness. The form and nature of the surface largely govern the surface friction and lustre, and contribute also to the dye-absorptive capacity, which is much affected too by the internal organisation of the fibre. The chemical composition of the constituents of the fibre is largely responsible for the degree of its resistance to chemical and biological agents of degradation or destruction.

Table I shows how the common "cellulosic" fibres—flax, jute, and cotton—compare with one another in composition: for ease of comparison the results have been corrected to an air-dry basis in which the moisture content is the same (10 per cent.) for each fibre. It should be noted that the bast fibres are actually more hygroscopic than the cotton, and so contain rather more moisture at any particular relative humidity of the air.

TABLE I.

Fibre Composition

Constituent	Flax		Jute	Cotton
	Green	Rette		
Cellulose	56·5	64·1	64·4	87·9
Hemicelluloses	15·4	16·7	12·0	0·6
Pectin	3·8	1·8		
Lignin	2·5	2·0	12·0	0·0
Fat and wax	1·3	1·5	0·5	0·6
Water solubles	10·5	3·9	1·1	0·9
Moisture	10·0	10·0	10·0	10·0
Total	100·0	100·0	100·0	100·0
Ash	2·1	0·2	0·7	1·0
Nitrogenous matter	2·8	2·8	—	1·6

Table II. shows how flax, jute, and cotton compare for length and fineness of the ultimate fibres.

TABLE II.

Fibre Dimensions

Ultimate Fibres	Flax	Jute	Cotton
Range of lengths (mm.)	8-69	1-6	10-50
Mean length (mm.)	32	2·5	25
Fineness (grams per kilometre) ..	0·19	0·17	0·19

Table III shows how various natural and man-made fibres compare in specific strength—*i.e.*, strength per unit weight. The strengths in Table III are expressed as breaking lengths, *i.e.*, the length of the fibre sufficient to cause it to break under its own weight; some such basis is necessary to correct for fibre differences in specific gravity.

TABLE III.

Fibre Strengths

	Breaking length, kilometres	Flax = 100
Flax	59	100
Hemp	54	91
Ramie	51	86
Silk	38	64
Silk	38	64
Jute	34	58
Cotton	33	57
Wool	12	21
Nylon	44	75
Acetate Rayon	12	21

These tables show certain striking differences between the different textile fibres, *viz.* :—

(1) Large differences in composition between the two bast fibres, flax and jute, and between these fibres and cotton.

(2) Large differences in fibre dimensions between flax and jute, and much less differences between flax ultimates and cotton.

(3) Large differences in specific strength between the various fibres. It is noteworthy that the strength of flax is quite outstanding.

FIBRE AND FABRIC

As compared with other fibres the flax fibre has a relatively smooth surface that is responsible for the characteristic smoothness and lustre of linen fabrics, especially bleached fabrics. The fibrillar structure of the ultimate fibre is intimately connected with its being highly crystalline, each of the 36 million elementary fibrils in the ultimate fibre being composed of some 840,000 cellulose molecules,

arranged in the form of many thousands of crystallites. The high strength of the flax fibre is largely attributable to its highly crystalline structure, the direction of the crystallites being along the spirals making only a small angle with the axis of the fibre.

The large differences in composition between the bast fibres and cotton are responsible for many characteristic effects in the finished fabrics. The natural occurrence of the flax fibres in bundles renders them essentially different from the individualistic cotton fibres. As bundles the flax fibres are naturally very stiff; the stiffness decreases as the bundles are divided up either by mechanical or chemical means; the bundles are not ordinarily separated down to the ultimate fibres, and this tends to give flax fabrics a stiffer handle than cotton fabrics particularly in the unbleached state. In bleached fabrics yet another factor comes into operation due to the differential response of flax and cotton to what is known as *hydration*.

Hydration.—Hydration is a general term to describe the phenomena associated with the absorption of water by a substance. A number of chemical and physical mechanisms have been suggested to account for the water-absorption, and it may well be that the mechanism of absorption for one substance may differ from that for another. Certainly, the ultimate effects for different substances may differ widely. Like other textile fibres, flax undergoes hydration when treated with water. Thus bleached linen absorbs water from a wet surface very rapidly; it can actually absorb up to 20 per cent. of its own weight of water without feeling damp on the surface; the water-molecules enter the substance of the fibre, and, as one immediate consequence, the flax fibre swells. That some molecular rearrangement has occurred is clear from the fact that the strength of the fibre is increased by the wetting. What happens when the water is removed from the fibre by a drying process? Is the former state recovered? The answer is "No". On drying down after hydration fabrics made from flax and one or two other bast fibres acquire a characteristic plastic surface, which responds to mechanical finishing treatment to produce a very pleasing smoothness which is paralleled by no other textile fibre. It is the same feature in drying out after hydration that makes flax fibre unique for the manufacture of high class papers —such as the paper used for the £5 Bank of England notes. Possibly of all the accessory properties of the flax fibre, none is so important in its practical and economic consequence as this particular character acquired by drying after hydration.

We see now why it is that the flax fibre is especially suitable for certain classes of fabric. The rapid water absorption by flax, combined with its smooth surface, without loose protruding hairs, makes flax ideal for towels of all kinds, glass-cloths, and handkerchiefs. The high lustre of flax, enhanced by hydration in the finishing treatment, is advantageous in the manufacture of damask fabrics, in which the patterns are thrown up in clear-cut contrast to the background by means of differential reflection. The distinctive natural sheen improves the appearance of the fabric; it adds to its appeal and remains a permanent feature throughout its life.

Flax yarns and fabrics, unlike most textiles, increase about 20 per cent. in strength on wetting, a fact already alluded to, and one which is of considerable importance for fabrics that have to be subjected to repeated laundering. The high strength of flax accounts for the special demand for its use in the manufacture of many articles in

which strength is the first requisite. During the war green flax was specified for parachute harness, a great deal of flax of the highest qualities was consumed in making aero wing fabric for the Royal Air Force, and much was also used as sewing threads for service boots.

Finally, the strongest canvasses are made from flax. There is great demand for such canvas for the Royal Navy and for all the transport services, where the outstanding strength of flax shows to particular advantage. With such canvases unserviceability most frequently results from tearing; and the advantage which flax possesses in tensile strength appears in a magnified form in its resistance to

TABLE IV.

Results of Exposure of Flax and Cotton Canvases

May 1st, 1941—August 31st, 1941

	Flax Canvas (13·7 oz./sq. yd.)		Cotton Canvas (14·7 oz./sq. yd.)	
	Warp	Weft	Warp	Weft
Threads per inch ..	40	42	50	42
Counts	12·9 lea	12·4 lea	5/28s (cotton)	5/24s (cotton)
	Breaking Strength (lb./inch)			
	Warp	Weft	Warp	Weft
Unexposed	189	370	195	242
Exposed for—				
One month	177	360	182	227
Four months	147	293	131	193
	Tearing Strength (lb.) (tongue-rip test)			
	Across Warp	Across Weft	Across Warp	Across Weft
Unexposed	95	100	31	25
Exposed for—				
One month	71	86	28	22
Four months	44	61	16	17

tearing. This may be illustrated by comparing the results of tests on two canvases, one of flax and the other a high class cotton substitute of somewhat similar structure, exposed to weathering at the Linen Research Institute during the summer of 1941. They were placed on frames facing south at an angle of 45° to the horizontal so as to ensure the maximum rate of deterioration. The flax canvas was slightly lighter in weight than the cotton canvas but was made from rather coarser yarns; the results of the tests, given in Table IV, show that the resistance to tearing of the flax canvas was over three times that of the cotton canvas both before and after the summer exposures.

LINEN MATERIALS

For convenience we may summarise the outstanding characteristics of leading lines of linen fabrics, and indicate the flax fibre properties from which these characteristics derive.

TABLE V.

Linen Materials and their Properties

Table linen	Good lustre giving pattern contrast and smoothness of surface.
Bed linen	Smoothness, good handle, and coolness of feel (the coolness of feel arises partly from the smoothness of fibre, which leads to compactness of yarn and small air-content, and partly from the mechanical finish made possible by hydration).
Towels	Speed of water absorbency, combined with good handle.
Glass cloth	Speed of water absorbency, combined with absence of linting, the latter being due to the length of fibre in incompletely divided strands used for these cloths, and the difficulty of detaching fibre elements that have dried down after hydration.
Linen drill suitings	Coolness of wear, smoothness, and good launderability, consequences of the hydration effect.
Handkerchiefs	Speed of water absorbency and good appearance.
Fancy linens	Good appearance.
Tailor's interlinings	Stiffness and strength.
Aero Linen, Linen thread, Parachute harness	High tensile strength.
Canvas—Royal Navy, Railways	High tearing strength.
Hose pipes	Impermeability to water due to flax fibre swelling.
Banknotes	Smooth even surface and stiffness giving a "crackle" or "rattle", arising from the flax fibre hydration.

I think I have now said sufficient to justify my claim that flax utilisation presents a study in textile diversity. I emphasise this matter of diversity because it has

recently become fashionable to focus attention on textile unity to the exclusion of the diversity. The unity is found in the fundamental molecular structure of the textile fibres, and is of great importance in the search for new synthetic fibres. But with flax, as with the other natural fibres, the fundamental technical unit is the individual fibre. It is the individual fibres which are of outstanding importance throughout all the processes of production, from their extraction from the stem to their manufacture into yarns and cloths of very diverse types designed for very diverse purposes and uses. There is, indeed, a unity in all this diversity of production and utilisation; it is a unity which derives from that very wonderful fibre—flax.

DISCUSSION

THE CHAIRMAN: First of all I should like to congratulate Dr. Turner on an excellent paper. I would like ultimately to have the pleasure of thanking him for it, but now I will throw the meeting open for discussion.

Dr. J. VARGAS EYRE: My justification for speaking is that in 1919 I was entrusted with the task of establishing and developing the Research Association which Dr. Turner ably heads to-day, with the study of industrial problems, and the initiation of appropriate investigational work for the linen trade. I still maintain this interest, and well remember the importance attached to increasing our knowledge of the primary raw material, namely, flax. I came this afternoon to hear what developments have taken place in this highly-important sphere. Dr. Turner has undoubtedly made a valuable contribution to the general knowledge of the raw material for this delightful textile: indeed, in his lecture, he has done far more than this. He has stressed the importance of knowing all one can about the basic raw materials used in manufacture, particularly when they are natural products, in order that manufacturers, through their skill and appreciation of such matters, may turn such new knowledge to industrial advantage. A natural product is often capable, not merely of being completely transformed, but of being modified in the sense referred to by Dr. Turner, and knowledge of this may have a profound influence on industrial operations at the hands of those able to comprehend its significance. Therein lies industrial progress. During the past twenty years much has been learnt about flax, and I am convinced that the future of the linen trade grows more and more dependent upon this close study and the skilful utilisation of the fundamental properties and inherent characteristics of the raw material. From this point of view I would like to congratulate the lecturer in having given a refreshing example, which could well be copied by other sections of British industry, of the importance of a fuller knowledge of our basic raw materials.

Mr. RICHARD PORTER: I make a claim to be an expert in women's outer wear. Linen has been a favourite of mine, but its liability to crease has always been a great problem. I would like to hear from Dr. Turner whether this has been overcome. In about 1937–38 we were supplied with a linen which was called spiral spun, which never creased. To-day such linen as we can get hold of, creases if you look at it.

I have just returned from four years' service in the Middle East. There is a wonderful custom there: you get your cotton or linen clothes dressed by an Arab dhobie. He takes a mouthful of starch solution and blows it over the material, and then irons it, and the effect is simply marvellous. I have tried to impress on customers that that is what they should do with Irish linen.

I hope we shall be able to use a lot of linen in future, as it is a lovely material, but it must be crease-resisting.

THE LECTURER: I should like to thank Dr. Eyre for his kind words. I feel I am following in excellent footsteps in directing Lambeg, and he certainly laid an extremely good foundation at the Research Institute, for his successors.

As regards Mr. Porter's question about crease-resistent cloth, we are actually working on that subject at Lambeg, and we have produced crease-resisting effects in linen; but

as often happens, the result is not a 100-per-cent. success. We can make linen crease-resistant, but at the expense of a certain amount of strength. The treatments given to it tend to cause a drop in its strength, and also they interfere with the handle and with the draping quality. As the handle and draping qualities are extremely valuable properties of ordinary linen, it is a moot point whether the customer would prefer to have the creasing linen which has to be laundered more often, or the anti-crease one which does not fill the bill in quite the same way as the other. However, it is always the job of a research association to investigate and experiment, and having found out the snags, to remove them, and that is the job on which we are at present engaged.

Mr. J. H. ACKROYD: Dr. Turner spoke of the big three characteristics of a linen fibre —length, fineness and strength.

I wondered how the re-scutched flax tow compares in these properties with line flax.

I am interested in re-scutched flax tow, and should like to ask whether some alteration in the method of production could be made to produce a cloth which would not have the rough, harsh handle, so characteristic of the particular cloth.

THE LECTURER: As regards Mr. Ackroyd's question, so far as strength is concerned, there is nothing to fear in re-scutched tow. It is possible you may get even stronger results in the fibre simply because its fibre-bundles are not so finely divided, and when you test bundles of individual fibres—strands as we call them—up to a certain limit the more ultimate fibres in the strand the higher is the strength per fibre.

As regards the other qualities, you are obviously likely to suffer from the disadvantages associated with an increase in coarseness (because the bundle is not so finely divided) and with a reduced length, because the material is what it is—rescutched tow. You have broken up the material in the processing, and you cannot expect to spin the rescutched tow so finely as the line, and you cannot expect to spin it with such a great degree of regularity.

I feel sure you could get a very coarse fabric out of rescutched tow as strong as one from line, yet it would not be a fabric which you would regard as so satisfactory. It certainly would be more irregular and unsatisfactory in other ways; also it would be less clean generally, with shive on it, so that it would have a rougher surface. But, of course, you would be paying a very much less price for it, and what you would accordingly get would be a cheaper article.

Dr. EYRE: May I ask whether linen is not sometimes used inappropriately, inasmuch as the degree of fineness called for is neither compatible with the fibre nor the purpose in view, and in consequence the tendency to crease is accentuated. The very fine dress fabrics and so forth, which have been referred to are not so suitable as a heavier cloth would be. With this in mind one might increase the weight of the cloth and greatly reduce creasing. Fashion may be calling for the misapplication of very fine linen.

Mr. RICHARD PORTER: Yes, I think the dress trade would like a definitely heavier weight.

The manufacturer has gone too far towards the very fine cloths, and will produce what we might even call a georgette, whereas really for linen we want something much weightier.

THE CHAIRMAN: I should like to make one point about Dr. Eyre's remarks about research.

I think it is true to say the textile industries as a whole have been very forward in their outlook in that respect. The silk industry, for instance, set up the very first research association under the Department of Scientific and Industrial Research, at the end of the First World War. That research association, which flourished on its own for a time, some years later joined up with the Cotton Industry Research Association, which became interested also in rayon. Rayon is now about to set up its own research organisation and the wool industry have their own association in Leeds. So textiles were early in the field of technical research.

It has undoubtedly helped manufacturers to know more about their raw materials,

and to be able to use this knowledge with greater benefit to all concerned, including the consumer.

There is perhaps a danger, touched on by Dr. Eyre and Mr. Porter, in the technical improvements that have taken place as a result of research and all that has flowed from it, whereby manufacturers have tended to use the fibres just that little bit beyond where it is wise for them to be used to best advantage. There is, however, no doubt that if research had been conducted in other industries such as it has in textiles, it would have been greatly to the advantage of British industry.

There was another point I wanted to make. I would like to ask Dr. Turner what he thinks about it. According to the Trade and Navigation Returns of the Board of Trade last year, in 1938 we imported 40,000 tons of flax: in 1946 we imported 18,600 tons—less than half. In 1938, 2,650 tons came from Soviet Russia, and 15,500 tons from the other Baltic States. In 1946 nothing came from any of those sources, and the result is that Northern Ireland has turned very largely to the manipulation of staple fibre rayon. That may or may not be a good thing: I do not want to argue that tonight, but it seems to me it is a pity if Northern Ireland is not going to keep flax in the forefront of its textile production, because I think flax is a very important fibre. It figures largely in our exports, and I do hope that Northern Ireland will pursue its more natural and native fibre, *viz.*, flax.

I would like Dr. Turner to explain if there is any special reason—other than perhaps the desire of Russia to maintain all the flax production for its own purposes—that none is coming from the Baltic States.

THE LECTURER: The tendency referred to by the Chairman was proceeding well before the war. A large quantity used to be imported, especially into the eastern ports of Scotland, but this had been reduced considerably before the war, simply because Russia wanted her own produce for her own manufacture.

I should like to assure you that although Ulster has been going in for the manufacture of rayons of a special kind during and since the war, nobody there thinks that Ulster will go entirely over to such productions. There is no doubt that linen is the biggest industry in Northern Ireland still, and everybody there will be happy when the supply position of raw fibre and the number of spinners is such that mills can spin more yarn and factories then make still more linen fabric than they are making at the present time.

Dr. EYRE: Both you, Mr. Chairman, and I have referred to the great benefit to industry arising from the scientific work being done by the co-operation research associations. May I quote some figures which bear upon this, which raise the further question whether we are wise in concentrating attention on training recruits for industry only at the university level? The figures are from the last census of production, and are given from memory. It appears that at that time there were some 140,000 factories in the country, of which 86 per cent. employed fewer than 100 people, and 97 per cent. fewer than 250 people. How many of these small establishments can accommodate, or afford to carry say two or three university graduates? They will be fully occupied with the details of their own processes and will have to look to an appropriate research association for scientific guidance and new knowledge. Recruits to industry at university level are badly wanted by the 14 per cent. comprising the larger establishments, research associations and Government departments, but, owing to the necessity in this country for an industrial drive of greater and better production from restricted raw materials, it seems to me equally necessary to focus attention upon technology, and the need for some recognised scheme of training and advancement in that important branch of industrial life. If we were to do that, encouragement would be given to those already in industry and recruits of a more generally useful type would be available to those who constitute the 86 per cent. to 97 per cent. who are in an equally sorry plight.

THE CHAIRMAN: It is being realised by manufacturers now more than ever before how important research is to industry and I think we have had here this evening a convincing demonstration of what can be achieved by a research association for an industry.

Now, thank you, Dr. Turner, for coming here from Belfast and giving us such a comprehensive and erudite paper on flax and what can be done with it. As I said before, I know of nobody more competent to talk to us on the subject, and I think that opinion has been clearly demonstrated by the way in which Dr. Turner has put his subject over.

Therefore, on your behalf, I will tender to him a very grateful vote of thanks for his paper.

The vote of thanks was accorded with acclamation and the meeting concluded with a vote of thanks to the Chairman.

GENERAL NOTE

CHEMICAL SOCIETY CENTENARY AND THE ELEVENTH INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY.—In the Society's rooms on February 23rd, 1841, twenty-five gentlemen "deemed it expedient" to form a society whose chief object would be the advancement of chemistry. This decision has proved very significant in the world of chemistry for on that February evening in London there was formed The Chemical Society, now the senior society of its kind in the world. Many other chemical societies in other lands have modelled their organisation on the Chemical Society, and in Rome in 1938, when the Tenth International Congress of Pure and Applied Chemistry took place, it was agreed that the Eleventh Congress should take place in London at the same time as the Centenary Celebrations of the Chemical Society. In 1941, the scene in London was very different to that anticipated in Rome in 1938 and only a brief formal recognition of the Centenary took place in the Chemical Society's rooms in Burlington House.

When hostilities ceased in 1945, the Chemical Society Council decided to hold its Centenary Celebrations in London in July, 1947, and the Congress authorities therefore decided to hold the Eleventh International Congress of Pure and Applied Chemistry immediately following the Centenary Celebrations.

Thus, we see that the seed planted in 1841 in the Royal Society of Arts flourished in 1947 into the bloom of the greatest meeting of chemists which has yet taken place in the world. Representatives of twenty-eight nations came from the ends of the earth to pay tribute to the Chemical Society. This is because it has stuck steadfastly to its purpose of advancing chemical science and has achieved its purpose to the admiration of chemists wherever they reside.

The respect commanded by the Society is reflected by the programme of the July celebrations. On July 14th at the Science Museum the Rt. Hon. George Tomlinson, M.P., Minister of Education, presided at the opening of an exhibition specially arranged by the Chemical Society and the Department of Scientific and Industrial Research to illustrate the historical development of chemistry in Britain since 1841, and to demonstrate the part played by chemistry in every-day life. This excellent exhibition, which has already commanded much public attention, has been most carefully prepared and together with the authoritative catalogue entitled "Chemical Progress" provides a unique account of chemical achievement in Britain during the last 100 years.

On Tuesday, July 15th, a colourful and dignified ceremony took place at the Central Hall, Westminster, when overseas delegates and representatives from sister societies in the United Kingdom presented addresses of congratulation and goodwill to the President of the Chemical Society, Professor C. N. Hinshelwood, F.R.S. Among the addresses was one from the Royal Society of Arts presented by Sir Harry Lindsay, Chairman of Council.

His Majesty's Government acknowledged the importance of the Chemical Society by providing a lunch to the overseas delegates on July 15th, over which presided the Rt. Hon. Herbert Morrison, M.P., Lord President of the Council, and by the attendance of the Prime Minister at the Centenary Dinner later in the day. Conspicuous among Tuesday's events was the magnificent Centenary Address by Professor Hinshelwood. The historical and philosophical aspects of a century of chemistry were dealt with in a

masterly fashion and, together with the lecture delivered by Sir Harold Hartley before the Royal Society of Arts at a special commemorative joint meeting in February of this year (*Journal*, Vol. XCV, page 454), the Centenary Address is an outstanding contribution to chemical literature.

On Wednesday, July 16th, scientific lectures and visits to chemical laboratories took place, the chief event being the Faraday Lecture. This Lectureship is the highest honour in the power of the Chemical Society to bestow and the 1947 lecturer was Sir Robert Robinson, the President of the Royal Society and the 1947 Albert Medallist of the Royal Society of Arts. In the evening London University conferred honorary degrees and Imperial Chemical Industries gave a reception. On Thursday, there was another programme of visits to chemical laboratories. The Opening Ceremony of the Congress also took place in the morning at the Central Hall, Westminster, and the programmes thereafter overlapped. In the afternoon His Majesty's Government arranged a Garden Party and in the evening receptions were held at the Royal Society and at the Royal Institution, when honorary membership was conferred on some of the distinguished chemists attending.

For a further week until July 24th, the chemists have met in some fifteen different sections to discuss topics of widely varied chemical subjects such as penicillin synthesis, radiochemical laboratories, glass and ceramics, cosmetics, endocrinology, dietary restriction, coal, alloys, electrodeposition, etc. Highlights of the programme have been the six Congress Lectures delivered by chemical leaders from six different countries. Interspersed with these scientific events has been a social programme of great interest and attraction. Receptions, lunches and dinners have been provided by the Royal Institute of Chemistry, I.C.I., Ltd., the Society for Visiting Scientists, the English Speaking Union, and many other organisations. Visits have taken place to Oxford and Cambridge as well as to places nearer London, like Kew Gardens.

When the two thousand and more chemists have returned to their respective homes we can be certain they take with them much new chemical knowledge, many new friendships and happy memories. So are forged the links of the internationalism characteristic of science.

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4749 *FRIDAY, AUGUST 15th,* 1947 Vol. xcv

EXHIBITION OF COLOMBO CATHEDRAL COMPETITION DESIGNS

The winning and other designs entered in the competition for the proposed Cathedral of the Holy Cross, Colombo, Ceylon, will be exhibited at the Society's House, 6–8 John Adam Street, Adelphi, London, W.C.2, from Monday, August 25th to Saturday, August 30th, inclusive.

The exhibition will be open on Monday to Friday from 9.30 a.m. to 5.30 p.m., and on Saturday from 9.30 a.m. to 12.30 p.m.

PRESENTATION OF ALBERT MEDAL

On Monday, July 28th, Sir Harry Lindsay, Chairman of the Council, presented to Sir Robert Robinson, P.R.S., the Society's Gold Medal which had been awarded to him "for his outstanding contributions to the advancement of organic chemistry". Members of the Council present were: Mr. F. H. Andrews, Sir Frank Brown, Major W. H. Cadman, Sir Atul Chatterjee, Sir Edward Crowe, Professor E. C. Dodds, Sir Thomas Dunlop, Professor C. S. Gibson, Mr. E. W. Goodale, Dame Caroline Haslett, Sir Henry McMahon, Mr. F. A. Mercer, Mr. John A. Milne, Sir Ernest Pooley, Mr. J. W. Ramsbottom, Mr. E. M. Rich, Mr. A. R. N. Roberts, Mr. E. Munro Runtz, Mr. Gordon Russell and Mr. William Will, with Mr. K. W. Luckhurst (Secretary) and Mr. C. J. Buchanan-Dunlop (Assistant Secretary).

Lady Robinson and Lady Lindsay were also present.

THE CHAIRMAN, in making the presentation, said: Sir Robert Robinson, on behalf of the Council and Fellows of the Royal Society of Arts I have the great honour and privilege of awarding to you with due ceremony to-day the Albert Medal of the Society for the year 1947.

Eighty-four years ago, in 1863, this Medal was founded to commemorate the long association of the Royal Society of Arts with the Prince Consort, who was one of our most illustrious Presidents. It has been awarded annually since then for high distinction in promoting arts, manufactures and commerce, the very object for which this Society itself had been founded over 100 years earlier. Many distinguished men have received this award—men both of this and of other countries who have devoted themselves to practical science and technology.

In your particular case, Sir, the award reads as follows: "For outstanding contributions to the advancement of Organic Chemistry"; and these words have been incorporated on the rim of the Medal.

I do not presume, Sir Robert, to recite the many honours which have come to you. It is a long list. In view of the close interest taken by this Society in the Overseas

Empire, we are glad to note that your first Professorial Chair was that of Organic Chemistry, Pure and Applied, at the University of Sydney, New South Wales; and we note also that you were only twenty-six when you first occupied the Chair. You have subsequently held similar Professorships at Liverpool, St. Andrews, Manchester, and University College, London, and you have been Fellow of Magdalen College and Waynflete Professor of Chemistry, Oxford University, since 1930. You are President of the Royal Society and a Past President of the Chemical Society.

Let me quote the words in which a distinguished fellow-scientist and a Member of Council of this Society recently summed up your work in the field of Organic Chemistry:

> "During the last thirty years Sir Robert Robinson has become the recognised leader in this science. More than any other organic chemist he has made contributions of the highest importance to our knowledge of the mechanism of organic chemical reactions which have inspired other workers in organic chemistry everywhere. Science, and an appreciation of harmony in nature, combined to make his studies of the constitution of the colouring pigments of flowers a delight not only to chemists but also to all who appreciate natural beauty. The manner in which he has indicated how plant alkaloids may be evolved in nature and his contributions to the elucidation of the difficult problem of the constitution of the alkaloids of the strychnine group have never been surpassed by any previous worker.
>
> "We shall always remain indebted to him for the knowledge and genius which he has exercised in his elegant syntheses of compounds of the sterol group and other hormones, whereby healing and alleviation of physical suffering may be achieved. His recent contributions to the chemistry of the antibiotic substances, particularly of the penicillins, will prove to be of the greatest importance and benefit to mankind".

Indeed, Sir, we are fortunate in having caught you to-day, if I may put it so rudely, during a period of intense activity in the British world of science. You have recently read the Faraday Lecture and received the Faraday Medal, in addition to your other duties related to the Centenary Celebrations of the Chemical Society—celebrations in which the Royal Society of Arts was honoured to participate. Will you please regard this afternoon in the company of the Royal Society of Arts Council as a sort of breathing space, a recreation time, in the intervals of your busy life of national, Empire and international service?

On behalf of the Council and Fellows of the Society I have much pleasure in presenting you with this Medal.

Sir ROBERT ROBINSON replied: I am overwhelmed by the honour you have done me and by the distinction with which you have recognised such poor service as I have been able to give. I am also flattered by the compliment which you have all paid me in coming here this hot afternoon to do me honour.

In your reference to the Chemical Society's Centenary, Sir, you very modestly omitted to mention the very distinguished part which the Royal Society of Arts played in the foundation of the Chemical Society, and to which perhaps not sufficient attention has hitherto been paid. If the Royal Society can be regarded as

the ancestor of all the scientific societies, then certainly the Royal Society of Arts was the direct parent of the Chemical Society. The movement to form it 100 years ago originated in this Society. Since that time, this Society has played a very great part in the science of chemistry, particularly in regard to its relations with men like the Armstrongs, Pope, Gibson, Dodds, etc. Therefore, as I owe my whole scientific life to the activities of the Chemical Society, in whose proceedings the whole of my work is published, that is perhaps the first reason why I have to be grateful for this highly pleasant connection with the Royal Society of Arts.

It is also certainly true that the Royal Society of Arts originated the 1851 Exhibition, and one of the outcomes of that exhibition was the formation of a Royal Commission which has certain funds and which dispenses scholarships and studentships to persons worthy of them. I have to admit that had I not received one of those studentships I should now be a manufacturer. It determined my road at the parting of the ways, and instead of embarking upon an academic career I should have gone into my father's works—though I should probably have been equally happy in either.

These are points of not very general interest, but I am extremely grateful to all of you for this very kind recognition which you have shown me to-day, and I am particularly proud of the honour in view of the names of those who have preceded me.

I should like to add that I accept this Medal also in part recognition of the work of my wife, who is here to-day, because she has assisted me throughout my whole career, and she is very keen on laboratory work.

GAS IN THE HOME

By Mrs. G. E. Abbott

Organising Secretary, Women's Gas Council

Ordinary Meeting, Wednesday, May 7th, 1947

Sir Charles Tennyson, C.M.G., *in the Chair*

The Chairman: The Royal Society of Arts has a most laudable custom, and that is, that the Chairman at these meetings does not make a long speech beforehand. So all that I have to do is to introduce to you Mrs. Abbott, who has had five years' experience of the gas industry from inside, and a much longer experience of gas as a housewife and a user. I am sure we are going to enjoy very much her paper on this important subject.

I will not do more now than to ask Mrs. Abbott to read her paper.

Mrs. Abbott then read the following paper:

A sixteenth century alchemist gave gas its name. Jean Baptiste van Helmont, born in Brussels in 1577, began by studying medicine, but soon turned his attention to chemistry, becoming, in the words of a contemporary writer, "A man of parts who divined into the secrets of the Arts". He shared the belief of his time in the existence of the Philosopher's Stone or Elixir of Life, and claimed that he himself had turned metals into gold; it was a claim, however, which despite many subsequent experiments, he was unable to substantiate.

One day, while working in his laboratory, van Helmont made the startling discovery that a heated crucible "did belch forth a wild spirit or breath". Probably he was at first frightened on seeing, or feeling, the presence of this silent and uncanny spirit. "This spirit", he said, "up to the present time unknown, and not susceptible of being confined in vessels, nor capable of being reduced to visible body, I call by the new name of GAS". It is possible that he derived the word from the Greek "chaos"—without form.

Curiously enough, the word "gas" did not come into general use until over 100 years later. In the eighteenth century gas was known as "the spirit of coal", which is not a bad description, and as late as 1812, the Gas, Light and Coke Company received statutory powers to make and distribute "inflammable air".

The theory that the word "gas" is made up of the first letters of the names of three gods worshipped by the ancient East Indians may be apocryphal, but is intriguing.

Thus:—

G—for Ganesa, the god of wisdom and remover of obstacles.

A—for Agni, the god of fire.

S—for Surya, the sun god.

What an enchanting thought that the gods of fire and of the sun, to say nothing of the "remover of obstacles" god, are all contained in that homely word "gas"! How exciting to call upon the sun god to boil the kettle; upon the god of fire to light the coke boiler; and on "the remover of obstacles" god—is there a somewhat Chinese flavour about this god?—to remove drudgery from the housewife's daily round! What a boon to the single-handed housewife to have these gods at her beck and call and to be able to invoke their aid in transforming the house into a home.

The first house ever to be lighted by gas was that of William Murdoch, at Redruth in Cornwall, in the year 1792. Born in Ayrshire, the son of a miller and farmer, this Scotsman began experimenting with gas at an early age and—as might perhaps be expected, considering the country of his origin!—he was not content with its novelty but early concerned himself with its practical utilisation. He devised the first apparatus for making, purifying and storing gas with a view to supplying factories and homes. It was in an iron retort in the back yard of his house in Redruth that Murdoch generated the gas which was conveyed into the house by a pipe passed through a hole in the frame of a window. At first he only had one light but, later, gas was led to other parts of the house by means of tubes lighted at apertures here and there. Murdoch even made himself a portable lamp by confining gas in a vessel made of tinned iron, with a nozzle.

It was gas lighting which opened up a new, and hitherto unknown, use of coal. Coal was being mined in Great Britain about the tenth century, and in 1273 London declared war on the smoke nuisance by passing a statute prohibiting its use in the city. In 1306, Edward I. issued a restraining proclamation because of "the sulferous smoke and savour of firing", and in the reign of Queen Elizabeth she prohibited the burning of coal in London while Parliament was in session "because the health of the knights might suffer during their abode in the Metropolis".

We have not made as much progress as we might towards smoke abatement during the last three centuries, and the vital importance of this problem cannot be

over-stressed. Unquestionably, the use of gas makes a great contribution towards a purer and cleaner atmosphere in our towns.

It is interesting to note that gas "cuts" were known even in early Victorian days, although coal saving was not then the motive which inspired them, but the question of price. In the very early days of the gas industry, before meters came into use, gas lighting was sold on a fixed basis per burner, and according to the number of "contract hours". In an attempt to be fair to both company and consumer, companies employed inspectors to walk up and down outside in the evenings to note how many burners were "on" and whether they were being burnt outside contract hours.



FIG. 1.—*Streamlined fitments, hot water on tap, built-in gas cooker, gas refrigerator and an attractive dining recess are features of this kitchen*

No present day ministerial directive concerning fuel cuts could be more terse than the following note sent out to consumers by the Grimsby Gas Company in 1847 or thereabouts. It read, "The lights are to be extinguished within a quarter of an hour after the time contracted for, except on Saturday nights, when they will be allowed to burn one hour longer".

Tempting though it is to dwell on the interesting history of gas through its 150 years of progress, it is necessary to concentrate on the realities of to-day, and the urgency of the times calls for practical thought in the present tense.

The fuel crisis, which this winter changed so many homes in the course of a few hours into primitive shelters, without heat, light or power, brought with it a new

realisation of the value of coal and of those other forms of energy derived from coal, namely, gas and electricity. As we all know, the situation is serious, and, of necessity every household in the land becomes daily more "fuel-conscious".

We have avoided the inequality and burden of the rationing of gas and electricity for the time being, and it is not likely to be introduced if the housewife responds to the Government's request for a 25 per cent. reduction in the domestic consumption of electricity and gas during the summer months. Apart from ordinary waste, there are many directions in which gas, and therefore coal, can be saved without serious detriment to the cooking, water and space-heating services so necessary in modern life.

Planned fuel economy is inevitably associated with meter reading, which housewives are reluctant to undertake, although, in fact, once tackled, it presents little difficulty. Why not, in any case, interest the school-boy or school-girl, who might even be encouraged to read the meters for the neighbours and thus interest themselves in the economies to be secured.

Being like most of us rather wearied with the word "economy" I looked for another word the other day in an old book of synonyms, and found economy very rightly described thus: "The internal economy of a family depends principally on the prudent management by the female".

Coal is our greatest national asset. In the national programme for fuel economy there is bound to be an increasing emphasis on the fact that gas and coke represent the most advantageous use of the nation's coal.

Coal is not a simple substance, but a very complex mixture of valuable chemicals, and, scientifically treated at the gas works, it becomes the source, not only of two labour-saving smokeless fuels, gas and coke, but of a large number of other important materials. One ton of coal produces not only 75 therms of gas and valuable by-products, but also 10 cwt. or more of coke. It is not too much to say that the gas industry, through the treatment of coal, is providing many of the chemical substances of the modern world. One of the most valuable, coal tar, contains about a dozen primary products, from which the chemists build up over 2,000 new substances. It is interesting to note how many familiar things used in the home are included among these by-products, for example:—

Household remedies: aspirin, wintergreen ointment, disinfectants, D.D.T. and M. & B.

Plastics.

Ammonia compounds.

Flavourings: vanilla, cinnamon, almond, thyme.

Perfumes: essence of violets, orange-blossom, hawthorn.

Saccharine, moth balls, paints, lacquers, varnishes, rayon and nylon, metal polish, which is made from the dust of the gas works' flues—all these are by-products from the gas works.

As the title of this paper is "Gas in the Home", the main emphasis should be on the housewife's point of view. From her point of view I can certainly speak from experience, for, owing to the death of my mother, I began my career as a housewife at a very early age, and learnt through trial and error to run a home for my parson

father and the family. I have been a life-long housewife (nowadays "housewife" seems to have become a generic term and is applied to all women who have the care of homes), and have kept house as daughter, wife, mother and grandmother. My various homes were of different kinds, and ranged from an old-fashioned town basement house, through a house in the residential district of a northern industrial city, a house in the country, and a small London Regency house, to a modern centrally-heated flat. Social service work in the northern industrial city brought me into touch with women in the slum areas who were struggling against unbelievably sordid living conditions. These varied experiences have given me a wide knowledge of the difficulties with which housewives of all types have to contend—difficulties which should be a challenge to the planners of to-day.

The fundamental needs—material needs—of every home throughout the ages have been—shelter, warmth and food. Whatever form the shelter takes, be it "big house, little house, pig-sty, barn", the focus of interest is, and always has been, on that part of the house where food is prepared and eaten. Rightly therefore, the kitchen is recognised as the centre on which depends the health, happiness and comfort of the family.

For the past five years I have had the valuable experience of working with the gas industry and have seen for myself the contribution which this great industry is making towards a higher standard of home life.

The gas industry has always been interested in the question of the planning of the kitchen, apart from the design and performance of the individual appliances which make up the equipment of that important room. The industry has consulted with architects and planners, and, even during the war, had the enterprise and foresight to appoint a young woman architect to carry out research, both in England and America, on kitchens and everything concerned with kitchen planning.

Out of this research arose scientific planning of equipment, designed to save not only time and labour, but, what is still more important in these days, nervous energy.

It is curious that it is only within recent years that the housewife's time has been considered worth saving! It is certainly of no use to "educate her for leisure" unless we make sure, before we begin, that she has some leisure, and is not too tired to enjoy it.

In the planning of kitchens it is essential to take into consideration the needs of different types of households, such as those of large and small families, old people, and business and professional men and women, but there are some needs common to *every* household and things to bear in mind in the planning of all kitchens are:—

The right sequence of work (because kitchen work has its own pattern).

The saving of unnecessary steps.

Facilities for home laundry.

The provision of suitable equipment within the limits of the family budget.

The importance of the wise planning of kitchens is being realised by husbands as well as their wives nowadays, for the activities of the kitchen are no longer a closed book to the male members of the family. This is illustrated by a story I heard the other day. Two men, meeting at their club: "Hullo, you look very well, old chap. Have you been away? You're quite brown". "Away? Oh, no, but you see I'm *lucky*, our sink faces south"!

An intelligent approach to housework is needed—"Brains to save Brawn" might well be the slogan. What most women resent is not the job of work that must be done, but unnecessary labour—work which they feel need not be done if things were better arranged. That is what is meant by the word "drudgery". The changing attitude to housework, which is now coming to be regarded as a skilled craft, is illustrated by the recent formation of the National Institute of Houseworkers, whose aims are to raise the prestige of domestic work, to issue diplomas to qualified workers, and to provide free training to anyone intending to take up domestic work as a career. This experiment is being eagerly watched all over the world. For the first time in our history domestic work will be given the status of a skilled craft with regular working conditions and standardised rates of pay. This is a sound and practical attempt to solve one of the most pressing problems of to-day.

The second fundamental need for every home is Warmth. In this country, we are just beginning to plan space-heating on reasonable lines, for, unlike the Americans, whose more extreme winter temperatures have forced them to consider the heating of the house as a whole, our heating plans in the past have merely taken into account the warming of each individual room. As a result, it has been said that in winter the Englishman's home is not a castle but the smallest home in the world, because its comfortable living space has diminished into the area immediately round the sitting-room fire. An American magazine accused us recently of heating "not a house, but a few cubic feet of damp atmosphere in front of one or two hearths".

At last we are realising the disadvantage of such localised heating, and are planning space-heating to include halls, landings and bedrooms, as well as sitting-rooms—in fact the heating of the whole house. Coke can carry out the main heating during the colder months of the year and gas can supplement it by providing background warmth and intermittent heating.

An important point to remember about house heating is that in this climate, with its high humidity, air movement is needed both for comfort and to keep houses free from damp. The use of fires attached to flues ensures this air movement, and it is worth noting that scientists and other experts concerned with this problem of efficient house heating are, as a rule, in favour of the installation of flues to assist air movement and ventilation. The use of gas and coke ensures ventilation, since flues are an integral part of fitted fires burning these fuels.

The third fundamental necessity for every home is food, which, of course, implies the provision of facilities for cooking and safe storage. Gas is the most popular fuel for cooking, because of its speed and easily-controlled temperature. This fact is supported by the findings of the recent "Heating of Dwellings" enquiry published as part of the Egerton Report. Indeed, roughly nine out of every twelve families in this country use gas for cooking. As to storage, many housewives find that they have no adequate larder. For example, when large houses are converted into flats, it is sometimes impossible for each flat to be given satisfactory storage space, and in such cases the installation of a refrigerator is a necessity and will prevent waste of food and damage to health.

Kitchen planning and plans for adequate heat services will end in a dismal cul-de-sac if one factor is forgotten: the housewife must have the right tools for her job. More husbands might copy the example of one I know who, every time he buys a

new machine or tool for his factory thinks it only fair that his wife should also benefit and gives her something new for *her* workshop, the kitchen. The appliances for cooking, water heating, heating and the other tasks, must be suitable, and I am using the word "suitable" as a comprehensive one, embracing not only efficient performance but also economical running costs and attractive appearance.

Appliances must be easy to use, for the attainment of an improved and economical fuel service depends to a great extent upon the housewife's understanding of her

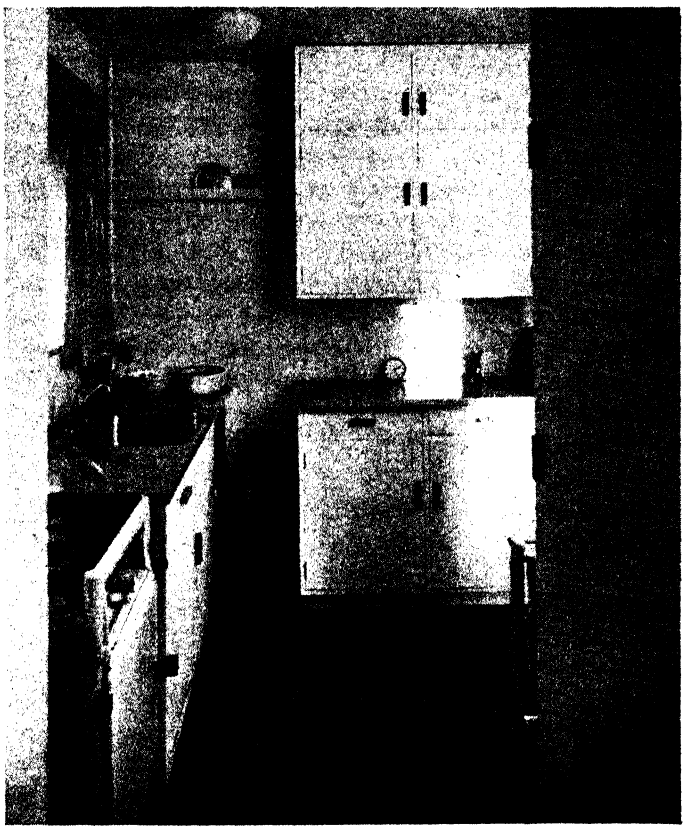


FIG. 2.—*A kitchen planned by the Women's Gas Council, in a recently built house near Dorking*

equipment and of how to make the best use of it; needless to say appliances should be well designed. There is a great improvement in industrial design. Not only are Design Centres being set up by important industries, but Design Advisory Panels are now being formed by women's organisations and, for the first time, women are able to contribute to industry practical and helpful ideas for improvement in design through official and recognised channels.

There is an insistent demand nowadays for colour in the home, and the kitchen especially should be pleasant to work in. The gas industry takes into consideration in the designing of kitchens and kitchen equipment the well-known fact that

cheerful and colourful surroundings help towards better work and the reduction of fatigue.

Gas Appliances

Gas appliances can best be considered in relation to the five important uses of gas in the home, which are: cooking, water heating, space heating, home laundry and refrigeration.

Cooking

Within the last ten to fifteen years there has been a great improvement in the appearance and efficiency of gas cookers. They can be of the vertical type, with the oven below the hot-plate, the range type, which has the oven and hot-plate side by side, or the eye level type. They can stand free or be built-in as part of a continuous level working surface. Automatic oven heat control is a standard fitting on all new cookers; grillers are speedier and cookers generally are easier to clean.

In these days of "staggered" meals, when members of the family are often on different work shifts, it is frequently necessary for prepared food to be kept hot. For this purpose there is the hot meal cabinet. A business woman can put a meal into this cabinet in the morning and find it ready cooked when she comes home, or food can be kept hot for the late-comer for supper and it will not have become dried up and uninviting.

Water-Heating

There are various solutions to the hot water problem, and all householders, whatever their mode of living, can find a system suited to their individual needs.

The well-known coke boiler can provide hot water for the whole house, but it is an advantage to have, in addition, a gas circulator attached to the ordinary circulating system which can be used in the summer months when the coke boiler is not needed.

There is also the independent storage water heater which combines the heating unit and an insulated storage cylinder. It is so designed that the gas is automatically lowered as soon as the water in the cylinder is hot.

The instantaneous multi-point water heater can supply bath, basin and kitchen sink with hot water and it has the great advantage that no gas is being consumed except for a small pilot flame unless hot water is being drawn.

A well-tried favourite is the single-point instantaneous sink heater, which can also, of course, be installed in a bathroom, and a popular new type is a boiling water heater which provides freshly boiled water for making tea in forty-seven seconds.

Space Heating

The trend to-day, at any rate in the Government-sponsored housing schemes, seems to be towards a combined space-heating and water-heating appliance for the main fire in the house. Arising out of this idea comes the pre-fabricated heating and hot-water service designed by the Ministry of Works for the small house. This is

composed of a central unit extending to the full height of the house, which can comprise a smokeless coke fire for the living-room with a back boiler to heat all the water in winter. A gas circulator can be fitted to the tank as an alternative hot water service in summer time when room warming is not required. One of the great advantages of this central unit is that warmed air is carried to the dining room and two of the bedrooms through ducts fitted for that purpose.

A sitting-room without an open fire seems to most people to lack a focal point, and the habit of sitting round and poking the fire dies hard. The new open coke fire, which is smokeless, has all the advantages of a coal fire, but lessens the work of the housewife, because it has built-in gas ignition, making it easy to light, and has also an ingenious regulating device which enables it to burn for about six hours without attention.

For the devotees of central heating a gas fired boiler can deal satisfactorily with the requirements of any type of house. It is automatically controlled, needs no attention, and combines cleanliness with efficiency.

Great advances have been made in the design and efficiency of all gas fires in recent years. New and much stronger radiants are one improvement; another is the use of a non-aerated or "neat" gas flame, which is quite silent in burning and which cannot "light back" when the fire is turned low. The new convector gas fire gives out radiant heat in the usual way and in addition warmed air for background heating which gives improved comfort conditions and for long-period heating is cheaper to run than the normal type of fire.

The provision of warmth in halls and passages, or, indeed, in any part of the house where steady background heating is required, can be done by flueless heaters which are pleasant and unobtrusive in design.

I mentioned earlier that I had lived in an old Regency house; this had been modernised and was entirely gas-equipped. Gas fires, plus gas rings, were used in the bedrooms and also in the dining-room, and a multi-point heater in the kitchen gave excellent hot water for the sink and for the bathroom, which was warmed by a gas wall radiator. The kitchen was heated by a flueless gas radiator and another of these was used in the hall. A smaller edition of this radiator was fitted into an old-fashioned cupboard in which the linen was aired and proved invaluable, and a drying cabinet was installed in the bathroom and was a real labour-saver. In the original sitting-room grate a smokeless fuel was used and was lighted by a gas poker. It was a great joy to live in a period house without any of the usual disadvantages of an old building and with many of the advantages that modern science could give.

Laundry

Nowadays we are returning to the habits of our grandmothers and doing our washing at home, with this difference, that, with the help of modern equipment, we are able to do it much more easily.

Where there is a utility room or laundry (or, as many women still prefer to call it, a "wash house"), the washing will naturally be done there; but where this useful room is lacking, space can usually be found for the necessary equipment in the kitchen.

Instead of our grandmothers' "dolly-tub" we have the gas-heated boiler or the washing machine which does in a very short time the washing which would have taken the mother of a family many hours of weary work to accomplish. The drying cabinet is steadily gaining in popularity, which is readily understandable as the whole family wash can be dried in an hour or so, and the housewife is no longer dependent on the weather. Although not strictly belonging to the wash-house I think this is the place to mention the new gas-heated towel rail which not only gives some welcome background heating but is most useful in both kitchen and bathroom for the drying of towels.

A recent competition for the design of gas irons produced some particularly good designs, some of these doing away with the cumbersome flex.

Refrigeration

Refrigerators, unfortunately, are still enjoyed only by a relatively small percentage of the population, but they have come to be recognised as a necessity and not a luxury. The gas refrigerator is automatic and, what is very important, silent in action. It can be free standing or built in to a kitchen unit, and there are sizes to suit either the bachelor flatlet or the family house.

It is, of course, possible to have almost anything under the sun if one has enough money to pay for it, but one of the chief attractions of gas and coke is that, properly planned and used, they give a complete service to the modern home within the limits of the average income.

In this country there are still many major household problems to be solved, such as the provision of housing of an adequate standard and the supply of piped water to every home in the land, and one of the most important problems of all is how to instil into the minds of the young generation, the Homemakers of the future, the value of Home and a sense of pride in Homemaking.

Some of you may have heard Mr. J. B. Priestley's introduction to the recent BBC series of talks on Atomic Energy. "By making use of Atomic Energy," he said, "we are turning the very Solar System into our Gas Light and Coke Company, as if we had telephoned to some helpful agent in the sun itself; we are trying to lay on and tap the fury and splendour of the constellations and galaxies. We have placed one halting foot on the stairway to the stars".

The vista is dazzling, but in the meantime, perhaps you and I may be forgiven for preferring the solid and assured comfort of gas; which also, be it noted, derives its energy, as do all forms of heat and light, from the sun.

DISCUSSION

The Chairman: What is meant by lighting back?

The Lecturer: I call it lighting back when you light the gas and it jumps; it strikes back to the nozzle, and lights inside the pipe.

If there is nothing controversial that you want to ask, perhaps *you* would give *me* some advice about a few things.

I thought you would be sure to ask me: "What about this gas rationing; how can the housewife economise? How can she be expected to have time to read the meter and check it?"

We at the Women's Gas Council are very busy trying to get out helpful advice and leaflets on these subjects, and if any of you could give us some new ideas for economy, we should be delighted to hear them. The usual ones are well known—such as "Do not boil any more water in the kettle than you are going to use", "Do not let the flames flare up round the saucepans and kettles", "Do not wash your hands under a running tap" and so on—but if there are any new and helpful ideas for the poor overburdened housewife, please hand them to me, so that I can pass them on to her.

A small sub-committee which has been meeting at the Ministry of Fuel—representative of the women's organisations—have been racking their brains as to how to put over to the housewife that it is absolutely essential that the saving should be made. How can we do it?

Miss MARGARET CLARKE (The Institute of Fuel): I noticed that in the very lovely demonstration kitchens shown on the slides, very few of the gas cookers were shown with flue outlets. I should have thought it desirable where possible to provide a flue because, apart from the advantage of carrying away the products of combustion, it is desirable to reduce the smell of cooking to a minimum. I think that where a gas cooker is installed with a flue there is much better ventilation of the kitchen than by any other method, but I should like the lecturer's opinion on this. Personally, I think that it is an improvement that should be pressed for.

THE LECTURER: When I mentioned flues in my paper I was talking about gas fires, and I know most gas cookers do not have flues. I think surely they would be there if the gas industry and the appliance manufacturers thought it was necessary. If there is an expert on that subject here, perhaps he would give us a few words on it.

Mr. E. W. B. DUNNING: As to ventilation of the kitchen, we do think the kitchen should have good ventilation for the removal not only of the products of combustion, but more particularly of the cooking smells, particularly preventing them from drifting round the rest of the house.

Some form of ventilation of the kitchen, natural ventilation or otherwise, is desirable. In the new Codes of Practice that the Ministry of Works sponsor, it is now recommended that the kitchen shall have ventilation of 1000 cu.ft./hour of fresh air with the windows and doors closed. This can be conveniently obtained by the provision of a flue or ventilation shaft of 30 square inches area. This flue may be used by a gas water heater or drying cabinet in which case the ventilation will be increased when the appliance is being operated.

Mr. L. W. ANDREWS: There is another Code of Practice—the code of good practice for the installation of gas appliances prepared by the gas industry. In that code it is recommended that under normal circumstances cookers shall not be flued.

Mr. A. FORSHAW: You will probably recollect that when you are using a gas cooker, or any other cooker for that matter, some 75 or 80 per cent. of the work is done on the hotplate, and it is very difficult to ventilate a hotplate in such a way that all the smells of cooking can be removed by a flue. We have had hoods and that sort of thing, but they do not usually get rid of the smells completely.

The other point—I do not know whether I ought to mention it here—for many years all cookers have had a flue outlet to which a fluepipe may be attached and in the past a great number of cookers have had fluepipes attached to them. Unless, however, a fluepipe is attached in such a manner that no down-draught can reach the cooker, it may be quite dangerous. If you attach a fluepipe to a cooker oven, you must, to promote safety, have an open end to that fluepipe below the flue outlet so that if a down-draught occurs in the flue itself, it will be diverted from the oven through the open end. If you do not do that you might get your burners put out and a dangerous state of affairs.

I can tell you from my own experience that I was once called to a place in the West of England where they had trouble. In that particular town every cooker had a fluepipe attached to it, but those responsible knew little of the intricacies of fitting flues to cookers and terminating them outside in such a position that down-draughts could not

occur. They were continually having explosions. Fortunately none did any particular damage, but they might have done had they got the requisite accumulation of gas. As a result of my visit I recommended them in future not to put flues to cookers unless they took the terminals of their flues to such a position that down-draughts could not occur, and that is not very easy. They do not, in fact, fit fluepipes to their cookers there now and their troubles have vanished.

The points to remember are that it is difficult to terminate a fluepipe in such a position that down-draught cannot occur, and provision must therefore be made so that down-draught cannot cause dangerous conditions to arise.

Mr. HUGH F. COCHRANE: I should like to make a suggestion in regard to gas cookers, that the oven door should be capable of being hung on either side of the oven.

The latest ones let down, but with the old-fashioned ones, planning is limited, because where the oven door opens back against the light, you cannot see into the oven.

Mr. DUNNING: There are not many cookers manufactured to-day which are arranged so that they could be left or right-handed, although there were some in the past.

The real reason is that there does not seem a demand for the left- and right-handed sort. There are difficulties, for example, in a new housing estate, where you have semi-detached houses, every alternate house is the other hand, so you would have to fit alternately a right-handed cooker and then a left-handed one all down the road, and you might get it wrong even then.

Most of the side-opening cookers do open right back, so that if you have got the oven door open it does not matter which side the light comes. It should be possible in designing the kitchen to alter slightly the design of these left- and right-handed houses, so that the kitchen, instead of being an exact mirror image in the case of the left-handed house, has the cooker so that the light is still on the correct side. You have the alternative drop door which enables the light to come from either side and gives a useful shelf for standing the food on when you move it in the oven.

Mr. ARTHUR TENNANT: I speak as a cook. I use a gas cooker, and I think a point that everyone has overlooked is that there is a thermostatically controlled oven. You put the food in and shut the door. There is no need to open the door at all until you take the food out.

There was also some discussion as to whether tea should be made from water from the hot tap and whether refrigerators which cease to operate should be turned upside down.

THE CHAIRMAN: I think we have had a most interesting discussion, and I am sure you would like me to thank the lecturer for her admirable and admirably delivered address, which covered the subject most beautifully. A tremendous amount of thought has been put into one's mind by this address.

Mr. Porter and I must form an organisation for domestic wage slaves, so that we can insist on turning our refrigerators upside down, and making the tea with water from the hot tap. I do not do the former, but I always do the latter, and have never yet been found out.

Mrs. Abbott's paper was beyond criticism except in one respect: she gave expression to one grievous fallacy. She said it is of course possible to have almost everything under the sun if one has enough money to pay for it. That is a Victorian view. It is perfectly useless to-day to have money, because you cannot buy anything at all. With all these lovely things you have seen, it may be if you go and live in Bolivia or Canada you can buy the refrigerator, and put in it three eggs, a quart of milk, and a chicken and so on; but if you cannot go to Bolivia you cannot do that, and very soon you will only be able to do it if you go to a dollar country, and that will not be allowed, so you will not get them at all. Still, it is nice to know that these things do exist, and that somewhere in the world someone is enjoying these wonderful products of the British gas industry.

I have always had the greatest admiration for the ingenuity with which the gas industry has developed that smelly product which in my youth I only saw issuing in the form of light from a very unattractive gas-jet, and adopted it for human use. I think it has been one of the miracles of our time.

I have just been told that the first use of gas by the Royal Society of Arts was in 1815, when a gas light was put over the entrance. Then gas was not considered suitable for indoor lighting. In 1835 a proposal to light the Meeting Room with gas was considered, but rejected as inexpedient. In 1847 the stairs were lighted by gas, at a cost for installation of £7 5*s*. (pathetic that!) In the following year it was introduced in the Model Room, and a central light was fitted in the Great Room.

Just outside in the hall you can see the pendant which has been used successively for oil, gas and electricity. I would like to be able to say it has been used successively for oil, electricity and gas, but my habitual sincerity prevents me from saying that.

I would like to tell you of my own personal experience. I recently moved into a new house, and I was very fortunate to get two of those wonderful gadgets you have seen on the screen. One was a drier, which is a marvellous thing, and the other was a gas radiator, which stands on the floor in the hall, and which I bought secondhand from the tobacconist at the end of the street. He was a most awful mug to sell it, for it is a wonderful thing. You will not be able to get one: I have a house, you see. You light it in the hall and all the heat goes up the staircase, and in that dreadful cold weather, I know you will be glad to hear, our house was beautifully warm.

I have admired the work of the gas industry and their efforts in the matter of design, in which I am deeply interested. They have succeeded in these years—150 years now—in making gas apparatus, which was once clumsy and ineffective, now efficient and harmless to look at—not more yet than harmless I am afraid. I am hoping that in the course of time they will make it beautiful. As Chairman of the Central Institute of Art and Design I know I can offer the industry the services of British artists to help towards that end. The gas industry have done a great deal in a difficult task to get design as good as it is to-day, but there is much to be done, and the time will come when it is a real pleasure to look at our refrigerators and all those other things, instead of it being what we may call a neutral process.

It remains only for me to thank Mrs. Abbott for this paper, which has certainly been one of the most interesting I have heard, and which led to one of the most stimulating discussions.

The vote of thanks was carried with acclamation and the meeting then terminated.

ELECTRICITY IN THE HOME

By Miss CAROLINE HASLETT, C.B.E., COMP.I.E.E.*

Director, Electrical Association for Women

Eighteenth Ordinary Meeting, Wednesday, April 23rd, 1947

Mr. H. T. N. GAITSKELL, C.B.E., M.P., *Parliamentary Secretary to the Ministry of Fuel and Power, in the Chair*

THE CHAIRMAN: When I was a respectable person, and before I had descended to the basement of the Civil Service, and from the basement to the pit of politics, I used to attend learned societies' meetings, and occasionally there was present at those meetings a distinguished Civil Servant, and I was always rather interested to notice that whenever he made any remarks he always began by saying, "I must make it plain that I am not speaking in my official capacity".

Now I cannot say that I am not speaking in my official capacity; that I think would be going too far, but what I have just said has some relevance, for this reason. We are going to have a paper on "Electricity in the Home". Now, if I were to come out with a statement showing strong support for electricity ahead of other forms of fuel, or, for

*Now Dame Caroline Haslett, D.B.E.

that matter, strong opposition to electricity as compared with other forms of fuel, I should get into trouble. I should be torn to pieces, because in this field between different forms of fuel the partisans are as keen as are the fans of rival football teams.

Therefore I give notice at once that my presence here this evening does not indicate any special lack of impartiality on the part of the Ministry of Fuel and Power. If we were to express partiality, I think we should have to do so on some more formal and State occasion. But while I am impartial to the extent that personally I use, when I can get it, almost all forms of fuel in my own house, I am not in the least impartial about Miss Caroline Haslett. It is indeed a privilege to be taking the Chair for her. Recently in an article in one of the evening papers she was described as Britain's busiest woman. If that be so—and there do not seem to be any rival claims so far—I think we are greatly honoured to have her here this evening.

She is the President of the British Federation of Business and Professional Women, a member of the Court of Governors of the London School of Economics—an institution with which indirectly I used to be closely associated—she is, I think, a Vice-President of this Society, and apart from these rather ornate positions that she occupies, she does other things. She has been putting the hosiery trade right lately, and showing them how to make silk stockings, and I understand has made a striking success with them. She is now proceeding to arrange for the building of a new town near Crawley, in Sussex.

Amongst her other recommendations is that she is—I can tell you quite privately—very closely consulted by the Ministry of Fuel and Power. She is very much in our confidence, and that, of course, is an exceptional thing. Of course, the reason why she has been asked here to talk on this particular subject is the quite remarkable work she has done for many years in connection with the Electrical Association for Women. She, if anybody, can claim to have brought home the benefits which electricity can bring to the housewife, and to have shown people what can be done. To-day we are going to have, in a sense I suppose, a summary of the present position from her. We are all delighted to welcome her here this evening, and I will now ask her to deliver her address.

Miss CAROLINE HASLETT then read the following paper:

When I was first asked to give a paper on "Electricity in the Home" I intended to prepare a conventional paper giving an account of all the ways in which electricity can be of service to the housewife, and with particulars of all the newest developments in apparatus.

In view of the present situation, however, such a paper would hardly be appropriate, and I have, therefore, preferred to relate the use of electricity in the home to the wider problem of the national economy, and especially to the great need to recruit more women for industry—in fact to the two-fold need to make the most efficient use of available supplies of both electric and human energy.

For the past twenty-two years my work has been the education of the public in the right use of electricity in the home—education aimed at spreading the knowledge that electricity is not just a fuel capable of providing light and warmth without the dirt and drudgery associated with the making and clearing away of solid fuel fires, but that it is also a force, a form of energy which can be used to replace human energy in a multitude of household tasks.

In the factory and, to a lesser extent, in the office, electric power is used to drive machines whose function is to increase efficiency while reducing human fatigue, and to enable fewer people to do a greater amount of work in a lesser space of time. In the same way, when electric energy is used with intelligence in the home, comfort and efficiency are achieved with the minimum expenditure of human energy, and the housewife has, in consequence, more time to devote to the arts of home-making

—time to be a companion to her husband and children, and time, if she wishes, for work, paid or unpaid, outside the home. This is of special importance to-day, when the housewife finds that all the routine tasks take much longer to do; shopping consumes more time; more time and skill are needed to prepare a nourishing and appetising meal out of what food is available; and curtains, carpets and loose covers and household linen, which would normally be replaced, have to be patched, altered and converted to fresh uses at home.

The National Coal Crisis

The recent crisis in electricity supply, when the use of electric power in industry had to be banned for a period and its use by the domestic consumer severely restricted, came to the disciples of the electrical way of living as a shock. Exceptionally severe weather conditions, making the maintenance of coal supplies to the power stations impossible, brought to a head a situation already made serious by reason of the shortage of coal in the nation and shortage of electric generating plant.

The Government in *Economic Survey for* 1947 has said that coal is the basis of the whole of the industrial programme of the country. In 1946 coal production was 189 million tons, and coal consumption was 194 million tons—a deficit of five million tons, which cannot be repeated, because there are now no stocks on which to draw. To enable the necessary stocks to be built up for next winter it is evident that not only must coal production be increased—as the Government envisaged—but also that the coal produced must be put to the most efficient use.

Effect on the Domestic Consumer of Electricity Cuts

The cuts in the domestic electricity supply meant not only that the all-electric house was without heat or light for five hours of the day—serious and comfortless as this situation was in itself—but also that the cooker, the vacuum cleaner, the iron, washing machine and refrigerator could not be used within these hours, and the tasks that they would normally have performed had, in the majority of cases, to be done by hand with the expenditure of a great deal of human energy, or alternatively had to be crowded into a few difficult hours of the day.

This bore doubly hard on those households whose life was geared to the electrical standard of living; where the housewife was perhaps managing all the work of her house and looking after her children without domestic help; or where electric power had set her sufficiently free from domestic duties to enable her to take up work outside the home. The ban on the use of electricity for domestic purposes within the prohibited hours gave the housewife only limited use of the tools which she needed for doing her job; while the volume of the work which she had to accomplish was in no way diminished.

The professional woman also, whose main energies centred round her chosen occupation, found her efficiency lessened and her emancipation threatened when she had to do the work of her home by old-fashioned methods.

The rural housewife, and the farmer's wife, again found special difficulties—the carefully planned routine devised to fit in with the work of the farm having to be reorganised at great inconvenience, to make use of electrical apparatus during the hours when current was available.

All types of households in all parts of the country were, in fact, affected by the new situation. For the period of emergency it was necessary to adjust to a different standard of living, and in many cases it was possible for temporary adjustments to be made through expedients which the housewife would not be willing to adopt as part of the normal pattern of life. If, therefore, the housewife is told that in view of the need for stringent fuel economy the full electrical standard of life has to be modified for the next few years, then it would be of advantage for us to analyse more closely than before the processes for which electricity is used in the home.

An impression is prevalent in some quarters that electricity is a luxury—an extra which can be dispensed with at the cost of inconvenience, but without real hardship. Though this impression might have been true many years ago, when electricity was used mainly to supplement other fuels, it is certainly not true to-day.

It is necessary to differentiate clearly between the use of electric current to fulfil the normal functions of a *fuel*, when it is used as an alternative to gas, oil or solid fuel, and its use as a force, to operate motor-driven appliances, when it is used as an alternative to human energy. This differentiation is of great significance for us to-day. The current consumption of electrical motor-driven household apparatus is relatively small. Any arbitrary decision to restrict the manufacture of such apparatus in an effort to reduce the consumption of current would have implications far beyond the actual saving involved.

There is a distinct danger of the present difficult situation carrying us back, not only to old ineffective methods of using fuel, but to neglect of the energy-saving aspect of electricity. Although human energy can, to some extent, be substituted for the energy of electric power both in the domestic and industrial field, no one would suggest a permanent ban on the use of power-driven machinery in industry.

All forms of energy are national assets, and these assets must be considered in their national setting against the background of the whole of the country's economy.

The ever-increasing need for more women in industry is one result of the battle for production. If women are to come forward in sufficient numbers for industry they can only do so if they are provided with labour-saving homes and ancillary services such as day nurseries; otherwise the result is likely to be overwork and a breakdown in health.

Women did splendid work during the war in the Services, in industry and in all phases of national life, but it is generally acknowledged that the hardest burden of all fell on the housewife who tried to combine work outside the home with keeping house for a family in a community which was not geared for this pattern of life. If, as a long-term national policy, it is accepted that Great Britain must make the fullest use of the labour of married women by asking them to engage in full or part-time employment outside the home, then it is obvious that labour-saving homes with the proper labour-saving tools for all household jobs are as essential a part of the national industrial equipment as the worker's factory bench.

The Relation of the Present Situation to the Living Pattern of the Future

The Government estimate that in the next twenty years Britain must build at least 5,000,000 houses, *i.e.*, house newly more than half her population. In Great Britain the life of a house is, with present building techniques, assumed to be some-

thing more than sixty years, *i.e.*, we are going, in the next two decades, to settle the living pattern for three generations.

It is for this reason that it is so important that the present fuel crisis should not be allowed to dominate the minds of those responsible for the provision of houses to such an extent that houses are erected without the necessary wiring, outlets and spatial planning to make possible the attainment of a full electric standard of living with all that it means in terms of cleanliness, comfort and the avoidance of unnecessary fatigue.

There is to-day a tendency to consider in some quarters that the development of domestic electrification has gone too rapidly ahead—that it has outstripped the capacity of the generating plant to maintain the domestic load, and that the need for saving the greatest possible quantity of coal is so great as to make the use of electricity for domestic purposes undesirable and uneconomic.

This tendency is aggravated by a confusion of thought regarding the two aspects of the problem of electricity supply—the short-term problem of the lack of generating plant, and the long-term problem of the need for economy in the use of coal. The first part of the problem should be solved, we are assured, within the next three years or so, when the necessary plant has been built, and indeed the Federation of British Industries has stated that generating plant should not—given all necessary priorities—take more than two years to build.

Domestic Electricity Considered in Terms of Coal

The other question—whether we can afford to use coal to produce electricity for domestic use might well be countered by the question—can we afford not to use it in this way? As far back as 1905 Sir Oliver Lodge referred to "The uncivilised and essentially savage method of heaping a pile of crude coal together and setting light to it".

Let us consider the question in its more simple aspect, leaving out of our calculations the fact that the present shortage of generating plant (which it is hoped will be overcome within the next two or three years) makes it desirable to keep our use of electricity within strict limits.

It is calculated that 1·4 lb. of coal is needed to generate one unit of electricity (War Period Report of the Electricity Commissioners, page 60, para. 461), even when, as at present, 60 per cent. of the coal used at power stations is of too low a grade to be used efficiently in any other way.

According to calculations issued by the Ministry of Fuel and Power in their pamphlet *Useful Facts about Fuel and Domestic Fuel Economy*, Domestic Fuel Memorandum No. P.2/23, the average living room fire consumes 2 tons 3 cwt. of coal per year. A careful housewife by using firebricks and sifting her cinders can reduce this consumption to about 1 ton 10 cwt. per year. It is calculated that she will use the fire for only nine months of the year, and that she will use eight time the quantity of coal in February as she does in September.

Without going into such technical questions as thermal equivalents, let us see what the housewife could have if she were to use the electricity generated by one and a half tons of coal. Allowing for a 12½ per cent. loss in distribution, 3,360 lb. of

coal will provide her with 2,100 units of electricity. This would enable the housewife if she used a one kilowatt fire, to have nine hours a day of constant heat, from the middle of October to the middle of April; leaving her with 300 uuits to use during the other three months. This is the minimum of electric heat she would obtain, since in practice, where the sole means of heating is electricity, the modern housewife could make use of more economical methods of space heating than the ordinary radiant fire, such as a thermostatically controlled convector heater or tubular heating. It may be said that electricity is coal with the drudgery taken out of it. The Ministry of Fuel and Power document which I have quoted above calculates that a coal fire will burn for six hours for 14 lb. of coal, while (again allowing for distribution losses) 14 lb. of coal will provide sufficient electricity to enable one-kilowatt electric fire to be used for nine hours. Again leaving aside the question of thermal equivalents, the housewife would appear to get the benefit of three hours' additional heat for the same consumption of coal; but there are also intangible savings in terms of human energy and time.

The expenditure of energy and time required to obtain electric heat is infinitesimal, being no more than is expended in the turning of a switch, and this expenditure remains constant, no matter in what part of the house the heat is required. The user of the coal fire, on the other hand, uses not only more coal, but also more energy—the so-far-unmeasured energy expended in the carrying of the solid fuel (varying, according to the distance from the coal store), the laying and lighting of the fire, the clearing away of the residue, sifting of cinders, and the extra cleaning associated with the dust from open fires. The saving, therefore, is best expressed not only in terms of saving of coal, but saving of coal + energy + time.

It is of interest that one unit of electricity (1·4 lb. coal) gives the use of:

A one-bar electric fire for one hour;
An electric oven for half an hour;
An electric iron for two hours;
A refrigerator for sixteen hours;
A washing machine for four hours;
A drying cabinet for half an hour;
A vacuum cleaner for five hours;
A mixer beater for ten hours;
An all-mains wireless set for sixteen to twenty hours;
A 100-watt electric lamp for ten hours;
Sixteen pints of boiling water from an electric kettle.

It is essential from the point of view of the domestic consumer that the housewife should have free choice as to the purposes for which she uses the electric current, which may be available within the framework of a national policy of fuel economy. She only is capable of deciding which of the services offered by electricity are most relevant to her needs, and which are the ones she would be prepared to reduce or dispense with under the pressure of an over-riding need for economy. The choice, for example, as to reduction in the use of the cooker or of the refrigerator; water or space heating; the vacuum cleaner or the radio, is a matter for her to decide in the light of the special needs and tastes of her and her family. The choice, if it is imposed by restriction in the national supply of coal, should not be further compli-

cated artificially by non-provision of adequate basic installations in new or converted buildings, or by artificial limitations on the supply of apparatus.

From these premises it may be useful to pass on to consideration of the various facilities offered to the housewife by electricity—the provision of the essential services of the home—space and water heating, lighting and provision for the carrying out of the various tasks of the home cooking, cleaning, laundry and the amenities of telecommunications.

Space Heating

Much has been heard in recent months of the perils of the "peak load". This in simple terms is the strain placed upon the generating plant when the greatest demand for electricity in the domestic and industrial fields occurs at the same time. In normal times the peak load can be met by bringing into operation additional generating plant; but the power stations are at present handicapped not only by lack of new plant to take the expanding load, but also by the fact that most of the existing plant is old and therefore less efficient.

The raising of the peak to a point at which it could no longer be borne by the power stations was undoubtedly in some measure a result of the indiscriminate use of electric fires to top up the warmth of background heating in exceptionally cold weather.

The restricted allocations of coal and boiler fuel caused the solid fuel consumer, whether housewife, hotel, office or shop, to seek to supplement this ration by the use of electric fires; or even to depend entirely on electric fires for space heating when the domestic solid fuel supply had run out or when gas pressure was too low to be an efficient heating agent.

Although there is still room for considerable research into the problem of space heating by electricity, modern methods are far in advance of the mere casual use of the radiant electric fire. Thermostatically-controlled apparatus, such as convector heaters, wall panel heaters and tubular heaters are means whereby a steady even flow of background warmth—where this is required— may be secured with a more economical consumption of current than is represented by the use of the ordinary switch-controlled electric fire. The latter should not, in general, be considered as adequate means of providing background heat in a dwelling, but rather as a source of heat for occasional use when future house installations are being planned.

Water Heating

The use of electricity for water heating is economical and efficient. The three principal types are:

(*a*) The open outlet non-pressure heater for local use above a sink or wash-hand basin;

(*b*) The electric pressure or cistern heater, supplying hot water to more than one point in a dwelling;

(*c*) The immersion heater in the hot-water storage tank, used for "topping up" and for summer use, in a system designed for heating by a solid fuel fire.

With electric water heating it is necessary to pay special attention to adequate lagging of the tank and hot-water pipes, so that as little heat as possible may be lost.

It has been calculated that with effective lagging of the type (*b*) heaters in a good installation a water heating efficiency of over 80 per cent. may be obtained. To obtain this maximum efficiency it is necessary to plan from the beginning the situation of the cistern heater, so that the pipe-runs to kitchen and bathroom may be as short as possible.

Multiple unit heaters of type (*b*) are designed so that small quantities of water at the top of the tank are made available without heating the entire contents. For this purpose one heater unit of ½-kW. is permanently in circuit to provide for sufficient hot water for ordinary domestic use. The main unit, heating the whole tank, may be switched on when baths are required.

The strain on the generating plant created by the use of electricity for water heating may be lessened by use of water heaters at night, rather than by day, where it is possible to instal fairly large storage tanks. Before the war it was, in some districts, the custom to make special arrangements whereby a considerably reduced rate was charged for domestic current consumed at night for the purposes of water heating. Electricity cannot be stored economically, but must be used as generated, and therefore the switching on of water heaters at night when the normal demand for current was low helped to spread the load, and was of benefit both to the power station engineer and to the consumer; while efficient lagging of the heater and pipes enabled the heat to be retained for long periods.

Lighting

Industry has, in the past few years, paid special attention to the relation of efficient lighting in factories to health and production, and the same principles may well be considered with regard to domestic lighting. It is an interesting fact that when the question of economising in the use of electric current is mentioned the first reaction of most people is to switch off the electric light, or to reduce the power of the lights in the house by substituting lamps of a lower wattage.

The proportion of the domestic load which is accounted for by lighting is relatively small. If 100-watt electric lights were to be left burning in every room of a ten-roomed house they could only consume in one hour the same amount of current as a one-bar electric fire would use in the same period.

Bearing this principle in mind it is necessary to consider what are the real needs of the household with regard to lighting from the point of view of safety, efficiency and comfort.

A Wartime Social Survey revealed how poorly lighted is the average home for even the most simple household task. Only one-third of the housewives thought that they could see well by artificial light. Over half the people had less than half the light they should have had in their kitchen-living room or sitting room for sewing or reading.

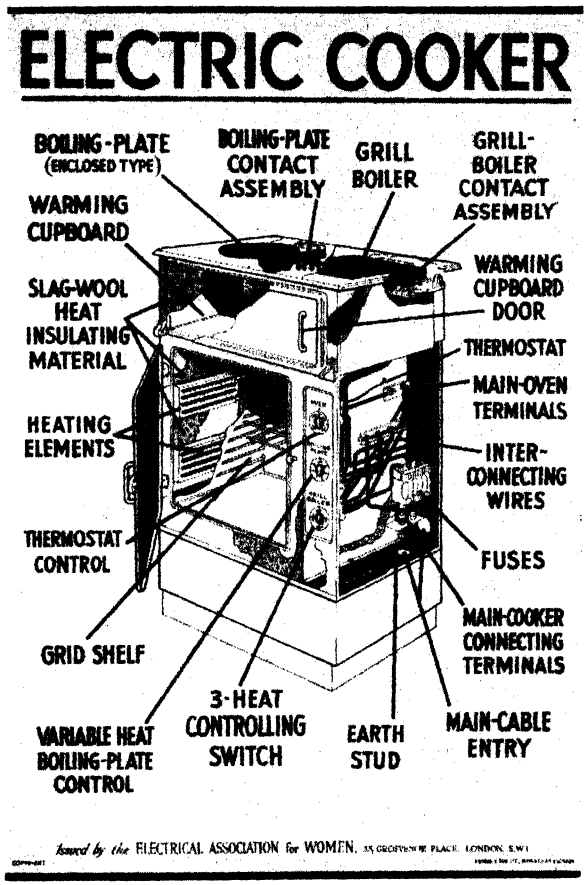
This is bad economy, both from their own and the national point of view, for there is no doubt that the morale and ability of people to work is a reflection of their home life and the comforts available in their home. There is no reason to-day why, in the home, in schools or at work, eyes should be strained for lack of light. For the present we may be restricted by the fuel situation to maintaining adequate standards of lighting rather than using it for decoration, but the housewife can look

forward to electric light, including the latest fluorescent lighting to give glareless light in abundance with minimum shadows.

COOKING

The use of electricity for cooking has manifest advantages; its complete cleanliness with the absence of any fumes or smoke make it, in fact, the ideal cooking agent.

There are many types of electric cookers which vary widely in design. Many



housewives prefer the horizontal type of cooker which stands at table height, so that it is unnecessary to stoop when putting dishes in the oven. The space beneath this type of cooker is frequently utilised for the storage of pans and similar equipment.

Some types of cooker are fitted with an inner door of glass which enables the housewife to see how her cooking is getting on without letting cold air into the oven with consequent detrimental effects on such dishes as cakes, pastry and soufflés.

In addition to the standard cookers designed to meet the needs of a family, there are several breakfast cookers on the market. Some of these are so designed

that they will not only cook breakfasts (*i.e.*, grill and boil), but also have a small oven and plate-warming space. This type of cooker is very popular for use in a small flat, as it will stand on a table, occupy little space, and yet is capable of cooking a meal for two or three people.

The modern oven is almost universally fitted with a thermostat, which gives absolute temperature control. Boiling plates also, in many up-to-date cookers, are fitted with a device which maintains a given temperature for an indefinite period. The degree of heat selected can be varied at will.

We may also consider in passing the other aids which electricity can give the cook. A machine is available to-day which carries out twenty different operations. It includes a mixing bowl and batter beater, and separate attachments may be procured to fulfil the complete range of functions: mixing (whisking, kneading, beating), vegetable peeling and washing, bread cutting, butter making, chipping and dicing, ice-cream freezing, drink emulsifying, breadcrumb crushing, coffee bean roasting, fruit stoning, apple peeling and coring, grating, meal slicing, sausage making, milk separating, bread cutting *and* buttering, fruit crushing, bean slicing, mincing. Such a machine will wash and peel 5 lb. of potatoes in 40 seconds, so its value to the busy housewife with a large family is considerable.

The waffle iron, the toaster and the coffee percolator are also useful kitchen or dining room accessories, while a new wheeled electric trolley has recently come on the market, fitted with four heat-resisting glass dishes, in which an entire meal can be cooked. The dishes are then placed in the wagon, and will keep hot and fresh for five hours. Provision is also made for keeping plates hot, and the whole piece of apparatus consumes only 200 watts of electric power.

Refrigeration

Refrigeration might be described as a complementary process to cookery. Food which is to be eaten uncooked should, in the interests both of health and palatability, reach the table in a fresh condition.

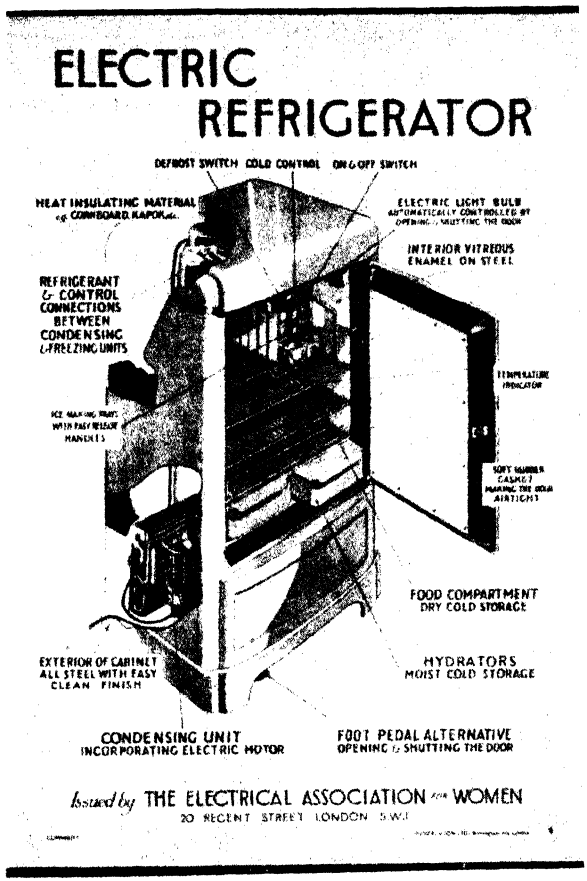
The consistent and correct use of a refrigerator avoids deterioration and waste of such foods as milk, fats, meat, fish and salads, which are in short supply, and which are essential to health.

The refrigerator can be used to some extent as an *alternative* to the cooker with a great saving in electric current consumption, since the average oven uses 1½ units in one hour, and the average refrigerator uses 1½ units in twenty-four hours. In summer especially, cold meals consisting of salads, chilled soups, cold sweets and drinks are attractive and healthful, but their popularity depends greatly on the use of a refrigerator, since there are few things less appetising than a tired salad, milk "on the turn" and rancid butter or margarine.

In America considerable use is made of the home freezer, and although this apparatus is not yet generally available for the domestic consumer in this country, it should be borne in mind as a future development in Britain. The home freezer may be used either for the storage of commercially frozen foods, or for the freezing of fresh picked fruit and vegetables, or home killed poultry, etc. For the latter purpose it should be specially useful to the rural housewife, since canning or bottling of poultry and home killed meat is not to be recommended on grounds of

safety. Another advantage of freezing over the bottling method is that it enables fresh fruit and vegetables to be gathered when the crop is ripe and served fresh at table months later.

In home freezing it is important to chill the food rapidly before freezing it. It must be chilled to below 50°F., the point where micro-organisms grow very slowly. Adequate storage temperatures are considered just as important as proper freezing equipment if foods are to be kept over long periods of time without deterioration.



The efficient home freezer, therefore, must provide a sufficiently low temperature for freezing, and maintain adequate storage temperatures for maintaining the food in best condition.

Cleaning

The task which many housewives find most onerous is that of keeping the house clean. In the all-electric house the minimum of cleaning is necessary, since dirt is not created by the presence of smoke and ash. Electric methods of cleaning remove the dirt and do not merely redistribute it. The apparatus most commonly used in

cleaning operations is the vacuum cleaner, and the electric polisher. The vacuum cleaner and its accessories remove all dust from carpets, hangings and upholstery very much more quickly and thoroughly than can be done by hand, and with a very small expenditure of electric current.

Another labour-saving device is a small all-purpose motor, fitted with brushes, which can be used for such varied purposes as buffing silver and brass and cleaning shoes, and which consumes only 200 watts.

For the housewife with a large family, a dish-washing machine saves time and labour. Such machines may be obtained either as an independent piece of apparatus, or as a unit to be used interchangeably with a clothes washing machine.

Laundry

The invention of the electric washing machine truly marked a great stage in women's emancipation; for clothes washing by old-fashioned methods is one of the most disagreeable and unrewarding of household tasks. The energy expended in the performance of the normal household wash is very great. To boil, wash and rinse a family wash could well occupy the housewife for more than half a day, after which the wet clothes had to be wrung out and dried, then folded, ironed and aired. The continual bending, stretching and lifting involved in these operations which have to be carried out in a hot steamy atmosphere, when old-fashioned methods are employed, is extremely fatiguing. By the use of electricity practically the whole of this fatigue may be saved.

Modern electric washing machines are of two types—the agitator and the cylinder type.

The agitator type consists of a round or square enamelled metal tub containing an agitator operated by a $\frac{1}{4}$-h.p. non-universal motor. The washer can be filled with water from a hose, and drained in a similar way, or a pump operated by the motor can be used for draining. In some machines a water heater is incorporated, in most no such provision is made.

Sometimes the wringer is a separate appliance, but more conveniently it is attached to the upper part of the machine, and can be swung into position. It consists of two rubber rollers operated by the electric motor. It has a safety release, and the action is reversible.

In the cylinder type the inner cylinder itself revolves, swirling the clothes round by means of lifter bars, and sluicing them through suction caps. In one of the most modern cylinder types the switch is set, and by a spinning action throughout, the clothes are automatically washed, rinsed and damp-dried.

Such a machine will wash, rinse and extract the excess moisture from a normal fortnight's wash for a family of four in less than two hours for a current consumption of 400 watts, or the equivalent of half a pound of coal.

The clothes when washed may be transferred to a small drying cabinet, which will dry three loads of clothes (the approximate equivalent of the wash mentioned above) in one hour for a current consumption of one unit.

Ironing

The electric iron is the piece of electrical apparatus which is in most common use.

The old fashioned electric iron, while possessing many advantages over the traditional flat iron, nevertheless left much room for improvement. The most modern irons are as far in advance of the early types as the former were an improvement on the traditional flat iron. Thermostatic heat control is an integral feature of the modern iron. Some are marked with dials indicating the temperature, others indicate specifically the right heat for the particularly material which is being ironed—the temperature requirements for linen, cotton, rayon and silk, covering a wide range.

Other modern irons incorporate a device whereby water is heated in the iron and projected as fine steam over the surface of the material to be ironed, thus ensuring the correct degree of even dampness for the best finish.

For heavy articles, such as sheets, towels, table linen, use may be made of a press iron—a piece of apparatus loaded at 1·2 kW., which exerts a pressure of 30 lb. and is controlled by a three-heat switch.

Telecommunications

Telecommunications is a word which gained in importance during the war. Applied to the home it includes such services as radio and television. Electricity also gives us the use of the telephone, although this is not usually considered part of the electrical equipment of a house. These contribute very greatly to the amenities of the home, and may be said to have transformed the lives of countless people. It may be expected that the use of television in the home will greatly increase in the next five or ten years, and its use should certainly be allowed for when basic installations are planned for the future.

Miscellaneous Apparatus

There is no time to enumerate all the other electrical apparatus which might well find a place in the modern home—nor is this paper intended to do more than indicate the various functions which electricity can perform for the housewife in the home. Mention should be made, however, of the electric sewing machine, which is invaluable in these days of make do and mend; the electric hair dryer, the electric fan, and apparatus used for medical or semi-medical purposes, such as sun lamps, vibrators, bed warmers and the like.

Conclusion

These are some of the most important services offered by electricity to the housewife, and they are services which she has a right to expect in any modern society.

It is certain that the old days of plentiful and cheap domestic labour have gone for ever, and that the housewife in the professional or higher income groups will have to continue to run her home with a minimum of domestic help.

The woman in the lower income groups, it is true, has traditionally always done her own housework—but in the main her work outside the home has not been such a valuable asset to the nation as it is to-day.

In order even to maintain the pre-war standard of life under present conditions the housewife must be able to use labour-saving apparatus—to deprive her of its use is to impose an unduly heavy burden upon her.

From nearly every section of the community to-day the demand is for shorter hours and for better working conditions. The only way in which the housewife's hours can be reduced is by giving her not only electric power and equipment, but also adequate instruction in the principles of electrical housecraft to enable her to make the most efficient use of her apparatus and her time. The electrical standard of living is a high one, but it is a necessity, not a luxury, under modern conditions.

It is not possible to have two widely differing standards of working conditions in the country—a high industrial standard and a low home standard. For the girls who have worked in industry and the Services during the war and during the post-war years have become accustomed to good welfare conditions and efficient methods of work.

It has been said with justification in the past that old-fashioned non-labour-saving methods of work in the home would have vanished long ago if the husband and not the housewife had to work in the home. The considerable amount of truth in this contention has been proved by the changes which have been brought about in working conditions in many homes during the war, when the men of the family had to take a share in the housework. The girls now taking up the task of running a home have a much wider experience of working conditions in the outside world, and they are bringing a fresh viewpoint which should widen and enrich the traditional craft of home-making.

DISCUSSION

Mr. R. BIRT: I would like to ask Miss Haslett one question with regard to the Government's or the Ministry's intention (as I read it by the statements that have been made) to co-ordinate the fuel industries. It would appear that in the future housewives will be told "You must have a gas cooker" or words to that effect.

Does Miss Haslett agree that the ladies will put up with that?

I can imagine that the Ministry, in reply to the lady who says: "But I don't want a gas cooker, I may have a headache in the morning," will say "By processing coal we are able to make aspirin to cure that headache."

Does Miss Haslett think that may come, as a result of the co-ordination of the fuel industries, and that the ladies will put up with it? Man may propose, but the ladies will have the last word.

Mr. H. BENTHAM, M.I.E.E.: Miss Haslett in the course of her paper made several references to the lower income groups and the difficulty of obtaining household help. Now the lower income groups cannot afford it and those who have the income cannot get it. The housewife will have all the work to do.

I speak as an all-electric householder: I have no coal ration at all. Consequently it has been rather dreadful for us during the blackout when we had a candle, and had to huddle together on the colder days. Apart from that, I dread to think what would have happened to my wife if we had not had an all-electric house. The all-electric house does not take nearly so much attention in connection with keeping it clean. The whole of the dirt and dust occasioned in a house is due to the fire, and I know, as Miss Haslett mentioned, about the man who, when he had something to say about the work in the house, had it altered to all-electric.

I have several undertakings, one of which is in Scotland, and I must say the Scots are far more electrically-minded than we are here. In that area I have several hundred pre-fabricated houses. These houses are all-electric. One of the local authorities changed its mind from installing gas cooking to installing electric cooking, after following careful enquiries which showed that everybody was in favour of all-electric cooking. Those houses are using 2,000–2,400 units a year, and it is costing the people who live in them —they are practically all miners who have the coal free—about 6*d.* a day each or

3*s.* 6*d.* per week per house for all the services which, with the exception of one coal fire, is all-electric.

Electric heating to-day is just as cheap, or in fact cheaper than, coal. It has many advantages, particularly in doing away with the exceptionally dirty job of cleaning up the fire.

Major CADMAN: We were told that 1·4 lb. of coal was required to produce one unit of electricity. Does that apply to ash-free coal, or to pre-war coal, or to the rubbish that is palmed off as coal to-day? If it applies to the very high ash content coal supplied to-day, I am afraid it will be necessary to alter the figure considerably.

I do not want to sit down without paying the highest possible tribute to Miss Haslett for her magnificent and brilliant lecture and to express a hope that you, Mr. Chairman, will ensure that the Minister has a copy of this paper when it is published. Also that the authorities who are considering the new Electricity Bill will realise what a vast range of electrical apparatus has been put on the market, because it has been announced that the Ministry is going to manufacture these appliances and distribute them in competition with the firms now producing them. I do hope the Minister will read this paper, so that he can realise the vast range of excellent appliances for heating and lighting and power which are at present in use.

Mr. A. B. READ, R.D.I.: I should like to ask Miss Haslett her views on the present practice of using built-in equipment. I have always been an advocate of the tidying up of domestic interiors, but it occurs to me that, because equipment can be put into such a limited space, the modern kitchen is being correspondingly reduced in size. The shape and size of the modern kitchen is dictated by the present standard design of unit equipment. Cookers and other apparatus may be replaced as improved types become available, but in all cases size is restricted to standard unit dimensions. These limitations of size and space may seriously handicap not only the design of present equipment, but may make the introduction of new apparatus quite impossible.

In the basement of Miss Haslett's own building we inspected an enormous kitchen range, and I expect that when it was put in it was a most up-to-date piece of apparatus. However once a thing like that is installed it is a major operation to remove it. So with the present practice of installing unit equipment, apparatus may have to remain even when technical developments have made it out of date.

I would like Miss Haslett's views on the merits of unit equipment as against portable apparatus that can be scrapped and changed more easily.

THE LECTURER: Mr. Birt has asked me a very controversial question. I would like to answer by quoting a speech which I heard Mr. Shinwell make—Mr. Gaitskell did not seem very willing to answer this question for me, and I have no authority. At the I.M.E.A. Annual Dinner last year this question was put to the Minister, and his answer was that there must be freedom of choice of fuel for the individual. I feel sure if we have fought for freedom in this country it must apply to freedom of fuel choice as in most other things. No woman would be agreeable to being restricted as to what kind of fuel she used; it must be the choice of the individual.

Mr. Bentham, thank you very much for supporting me so wholeheartedly as to the great advance of the Scottish people, and the way the miner uses electricity.

I should like to thank Mr. Cadman for his kind words. As to his question, one of the leading lights of the Central Electricity Board is here. I think I said 60 per cent. of the coal to-day could not be used for any other purposes, and that figure was given in the war-time Report of the Electricity Commissioners, when I gather the coal was sometimes more slate than coal. I gathered that this figure would be much better, speaking in general terms, when we get some new equipment and better coal.

I do not know whether it is wise for the Minister to read my paper. I might be very unpopular, but I feel gratified to think that you should consider he ought to read it.

I have been reading the Bill, and Mr. Gaitskell's wise words at the Committee Stage. I gather the Ministry has power to manufacture, but it is not probable that it will be exercised.

I would like to say that although enormous strides have been made in this country—and we compare very favourably with America, Canada and Sweden in the design and efficiency of our apparatus—as I know from recent visits—I personally am not satisfied. I think a lot more jobs in the home have to be done electrically than at present.

I do not know if I can give a clear answer to Mr. Read. The unit furniture has many great merits, but one is rather wedded to it for evermore. I think on the whole, while we should all expect to use our apparatus, say, for ten years or so, the feeling would be we should want a change. Why not interchangeability with the unit system as well? The great value would be standardisation and therefore cheapness. Can you not eventually have interchangeability with the unit system, a new cooker of the same size, but different design?

In America in 1944 they were talking of the importance of always keeping up to date with their apparatus—although I would not like to suggest this just yet for Great Britain. "The kitchen is just as important as the motor-car: why should we not turn in our kitchens every two years?" They were devising standardised walls, with a cooker and water-heating apparatus; after you had been married three or four years you became a little better off, and you turned these in for a more up-to-date kitchen wall on which was your washing-up machine. America is thinking in this way, and it is an enterprising attitude, which we might well copy.

THE CHAIRMAN: I told you at the start that Miss Haslett was very much in the confidence of the Ministry, and she has shown that by answering very capably the questions addressed not only to her, but those, perhaps by inference, addressed to me.

She was perfectly right on both points, and I do not propose to take the matter further.

We have listened to an extremely interesting paper, full of information, which I am sure many of us will wish to look at again, especially some of the more technical points in it. We have had some experience of Miss Haslett's capacity for dealing with points in discussion.

I wish we could have gone on a little longer, but I know you will join me in wishing to thank her, as indeed really you have already implied in your applause, in a more formal manner, for giving us such an extremely interesting hour and a quarter.

The vote of thanks was carried with acclamation and the meeting terminated after a vote of thanks had been accorded to the Chairman.

Mr. G. V. DOWNER writes: Much as I appreciated Miss Haslett's excellent and interesting paper, there were several points with which I could not fully agree, and in regard to which I feel that I am not alone.

Miss Haslett mentioned efficient lighting in factories and its effect on health, but in my experience, although many factories are using *more* light than before, there has been very little, if any, improvement in quality, or in the eyesight and health of staffs. On the contrary, I have noticed, as an apparent consequence, a great increase in the use of spectacles, and this is confirmed by the statement of the Secretary of the British Optical Association that there are now at least 5,000,000 more spectacle wearers in this country than before the war. Admittedly this increase is not entirely due to artificial light; there are many other contributory causes, but I feel that the bulk of the trouble is due to bad lighting in industry, and more especially to the use of excessive intensity and glare. This is particularly noticeable where fluorescent lighting has been installed. Glareless, shadowless and evenly diffused lighting conditions can be obtained quite simply and economically, using the old-time filament lamp. Furthermore, fluorescent lighting is very costly to instal, maintain and replace, with—as far as can be seen—no benefit, either physical or financial.

In regard to the design of domestic electrical apparatus, I thought the illustrations of cookers, water-heaters and refrigerators that we were shown all looked depressingly alike and I could not help wishing that designers would try to make these articles both more "functional", so that one could see whether one was looking at a cooker or a refrigerator, and at the same time more decorative, so as to give a little more variety both of form and colour to such articles.

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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ELECTION OF PRESIDENT

At an Extraordinary Meeting of the Council held on Tuesday, August 19th, Her Royal Highness The Princess Elizabeth was unanimously elected an Honorary Life Fellow and President of the Society.

The Council desired the Chairman to submit to The Princess Elizabeth a message of loyal greeting and a very cordial invitation to Her Royal Highness to honour the Society's House with a personal visit when other engagements permit, so that the Chairman and Members of Council and the Fellows of the Society may have an opportunity to welcome their new President.

Linlithgow Library.

HER ROYAL HIGHNESS THE PRINCESS ELIZABETH PRESIDENT OF THE ROYAL SOCIETY OF ARTS

The Council of the Royal Society of Arts announces to all Fellows and friends of the Society, with loyal pride and pleasure, that The Princess Elizabeth has honoured the Society by graciously consenting to become its President. Her Royal Highness has thus continued the tradition, which the Council and Fellows value so warmly, whereby members of the Royal Family have in past years filled the office of President. His Royal Highness Albert, The Prince Consort, became President of the Society in 1843. After his death Their Royal Highnesses The Prince of Wales (later King Edward VII), The Prince of Wales (later King George V) and The Duke of Connaught filled the office in turn.

When The Duke of Connaught, whose Presidency had covered a period of thirty years and who had taken a keen and active interest in the affairs of the Society, died in 1942, the Council cherished the hope that the link with the Royal Family would not long be severed and that The Princess Elizabeth would one day consent to become the President of the Society. This hope has now been realised.

At their meeting held on Monday, July 14th, 1947, the Council unanimously decided that their Chairman should on their behalf invite The Princess to become the Society's President. Her Royal Highness was accordingly invited and graciously intimated her acceptance. The Council has now unanimously elected The Princess Elizabeth an Honorary Life Fellow and President of the Society.

The members of the Council extend to Her Royal Highness their deep gratitude for her acceptance of an office which means so much to the success of their endeavours, together with the assurance of their loyal co-operation in all measures necessary to advance the work of the Society, to realise its objects and to ensure its continued progress.



Portrait by Dorothy Wilding

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RECENT AGRICULTURAL DEVELOPMENTS IN CANADA

By Lieut.-Col. J. G. ROBERTSON, B.S.A.

Agricultural Commissioner for Canada, and Chairman, Executive Council, Imperial Agricultural Bureaux

NEIL MATHESON McWHARRIE MEMORIAL LECTURE

Dominions and Colonies Section, Tuesday, February 18th, 1947

Mr. NORMAN ROBERTSON, *High Commissioner for Canada, in the Chair*

THE CHAIRMAN: It is my pleasure this afternoon to introduce to you Colonel Robertson, the Agricultural Commissioner for Canada, who has been honoured by an invitation to deliver the Neil Matheson McWharrie Memorial Lecture under the auspices of the Royal Society of Arts. Colonel Robertson is a colleague of mine in Canada House, but in spite of the similarity of our names there is no relationship between us! It is a pleasure to me to introduce Colonel Robertson with whom I have worked here and with whose son I have worked in the Department of External Affairs in Qttawa.

Colonel Robertson has had five years' experience in London as Agricultural Commissioner and in the course of that period he has been to Canada on several occasions and has therefore kept in touch with development in the field at home. While I know that you do not want to hear two lectures this afternoon, there are a few general introductory things I might say as a layman which, I hope, will not anticipate the ground which Colonel Robertson will cover. First of all it has always struck me as a layman and as a consumer that the quite remarkable increase in the physical production of Canadian agriculture during the war years in very difficult circumstances is a subject in which I, myself, would be interested. I would be interested in learning something of the technical developments which helped to make that possible, because in a period of diminished labour supply on the land and a period when agricultural equipment was steadily getting obsolete and could not be replaced, and when a pretty rigorous system of price control removed or diminished the sort of incentive which has, in most countries, been used to stimulate production, we still did contrive to step up production to heights which before the war would have seemed fantastic. Also, the general agricultural production of Canada was stepped up at a time when the whole of industry was being brought into mobilisation. In spite of the handicaps the total output over the war years was an extraordinarily formidable achievement. I think that Colonel Robertson can help to explain to us generally the technical factors and production policies which made that development possible.

Lr.-Col. ROBERTSON then delivered the following lecture:

Looking at Canada over a period of several decades, there have been tremendous changes in agriculture. Important changes have taken place during the past ten years. These have been chiefly of a scientific nature and also, in an equal sense, of economic importance. I propose this afternoon to deal with both phases of development, and will trace briefly some of the factors that have caused these developments to be brought about.

Scientific developments have been largely accomplished through the co-operation of governmental agencies, along with private initiative. By governmental agencies I mean departments of agriculture, agricultural colleges, experimental farms, breeding stations, insect control laboratories and machinery testing depots. Private initiative has been of great value too.

The history of the development of the Canadian Experimental Farm System is too interesting not to be briefly mentioned. It originated over sixty years ago, under the direction of Dr. William Saunders, with five farms scattered over the 3,800 miles which separate Halifax, N.S., from Victoria, B.C. It continued to develop under the able leadership of Dr. J. H. Grisdale, and has reached new heights under the brilliant guidance of Dr. E. S. Archibald, who spent some months in Great Britain in the summer of 1946.

The Canadian Experimental Farm System is now the largest in the world, and bears a very favourable reputation, comparable with American and British stations. It has grown from the five original farms with an area of possibly 2,800 acres to 29 farms of over 16,000 acres, six sub-stations, one fox ranch, eight pathological laboratories and 206 illustration stations and sub-stations. Under able directors it has played an important part in scientific developments in Canada. I will come to that in a moment.

Each province in Canada has a Department of Agriculture, so we find nine provincial departments and one federal department—ten in all. They are well staffed and play an important part under their respective Ministers and Deputy Ministers.

The Federal Department of Agriculture has for some years past been under the direction of men from my adopted province of Saskatchewan, and none will question the efficiency of the Hon. Dr. W. R. Motherwell, the Hon. Major Robert Weir, or the Rt. Hon. Dr. J. G. Gardiner, our present dynamic Minister. The present Deputy Minister is Dr. H. Barton, who has had an illustrious career in agriculture, and who has a thorough grasp of the four services into which the department is divided, namely—

(*a*) Science Service, under Dr. K. W. Neatby.
(*b*) Experimental Farms Service, under Dr. E. S. Archibald.
(*c*) Production Service, under R. S. Hamer.
(*d*) Marketing Service, under A. M. Shaw.

All are very able men, who have worked particularly hard during the war, have capable men under them and deserve a portion of the credit for the part played by Canada in increased food production during the war.

Some of my listeners will be well acquainted with these men that I have mentioned and others that time does not permit mentioning even by name. For example, the past head of the Science Service, Dr. J. M. Swaine, is very well and favourably

known in scientific circles, and has only lately been superannuated and succeeded by Dr. K. W. Neatby.

The agricultural colleges in Canada are nine in number (equal to the number of provinces). Seven are English-speaking and two French-speaking. The oldest and one of the best is the Ontario Agricultural College, Guelph. The O.A.C. is famous for many departments, not least of which is its live stock. MacDonald College has in recent years done much in research in animal nutrition, and has just this past year produced a very important malting variety of barley that will mean many hundreds of thousands of dollars to barley growers throughout Canada.

The Western Canadian agricultural colleges, one in each province, have each played an important part in agricultural development, in research, in extension work and in training leaders of farm work in their enormous areas. Far be it from my purpose to claim that they have done any better than agricultural colleges in Britain, America or the other Dominions or Colonies. All have done essential work.

Various laboratories for the control of many pests of different kinds are in the hands of competent scientists, some of them under the Dominion Science Service, others under the Experimental Farms Service, others under the provinces and still others that are more or less independent. Among these is the Imperial Parasite Control Service at Belleville, Ontario, where Dr. W. R. Thompson works under the direction of the Imperial Agricultural Bureaux, whose headquarters are here in London.

Recently a large co-operative research laboratory has been established in Northern Ontario to undertake research on forest insect control. Preliminary work is very promising, and, if successful, will mean the saving of millions of acres of forests and many millions of dollars to Canada.

Scientific Developments

Among the most valuable developments in plant breeding is that of the cereals: wheat, oats, barley and rye.

Wheat.—Wheat is of particular interest to Canada, because she is now the largest exporting nation in this commodity in the world. She is not the largest grower, for Russia, China and the United States grow much more wheat than does Canada. Even India frequently exceeds the Canadian record. But if India produces 400 million bushels of wheat, that is only one bushel per capita, and it is speedily eaten and the Indian people look around for more. Because of her small population, Canada can export large quantities and, as I said, is the largest exporter of wheat. One province, Saskatchewan, produces half the wheat grown in Canada, and the same province usually produces more than the Continent of Australia, or more than the entire Argentine Republic.

Wheat is, therefore, a very important crop, particularly on the prairies, where this year they grew 400,000,000 bushels of the total Canadian crop of 418,000,000 bushels.

The story of the development of this cereal is aptly called "The Romance of Wheat". Just for a moment let us go back to the time when mixed varieties of wheat were being grown. The first recognised variety, *Red Fife*, was introduced in 1882. This was a variety of remarkable quality and good yielding ability. Its propagation

quickly established a reputation for Canada as a producer of high-quality wheat. It was the best wheat then grown, but was too late in ripening to be a safe crop in much of the prairies. Plant breeding was in its infancy, so *Red Fife* held sway for over twenty years.

The Cereal Division of the Experimental Farms was headed by Dr. Charles Saunders, who won a knighthood and undying fame as the producer of a new wheat called *Marquis* that was equal to *Red Fife* in every way, and would mature a week to ten days earlier. It was also much more resistant to smut. This ability to ripen early meant that millions of acres could now be seeded to wheat safely, whereas they formerly produced little wheat. It meant that Western Canada increased her production of wheat by one hundred million bushels per year, and meant many millions of dollars to Canada. By 1928, fully 85 per cent. of the wheat grown on the prairies was *Marquis*, and by the production of this wheat alone the experimental farms and agricultural colleges paid for their upkeep for one hundred years to come.

But *Marquis* was not perfect. It was still a little late for some sections. Rusts and smut were also developing in Western Canada and *Marquis*, although a very fine, hard, good milling and good baking wheat, was not rust resistant, so the search went on for new wheats.

Reward, developed at the Central Experimental Farm at Ottawa, enjoys an enviable reputation as an early wheat, but falls short in yield per acre, and is not resistant to rust. It has been a consistent championship winner at "The International Hay and Grain Show" in Chicago, and other grain shows for the past 15 years. It was the winner of the World's Championship in Chicago three months ago.

Garnet, also produced at Ottawa, is very valuable where early frosts are feared, particularly along the northern fringe of the wheat-growing area. However, it mills into a flour which is more yellow than many other varieties and is not entitled to rank with *Marquis* in baking quality. In fact, it is not considered suitable for the three top grades of Canadian wheat, but is given separate grades, viz., *No. 1. C. W. Garnet*, *No. 2. C. W. Garnet*, and *No. 3. C. W. Garnet*. This makes it sell considerably lower in price than other varieties, yet it is a popular wheat in Northern Saskatchewan and Alberta.

The Challenge of Rust.—Rust, both stem rust and leaf rust, became very prevalent in Western Canada, and it was worse in years when rainfall was the greatest and crops were growing the best. Dry years are not so conducive to the development of rust.

Rust, by the way, is caused by an organism belonging to the fungi. It develops rapidly, particularly in moist hot weather, and, as a result, the grain shrinks and withers until very frequently it is not worth harvesting.

In one of the years of the first World War, the loss from rust in the three Prairie Provinces was estimated to be over $100,000,000.

During the tragic year of 1935 it has been carefully estimated at least that 85,000,000 bushels less wheat were harvested than would have been harvested had there been no rust. The loss in bushels added to the loss in grade brought the total loss in that one year to well over $100,000,000.00. The situation was extremely serious for the farmer and for Canada.

It must be remembered that the hybridisation and development of a new

variety of wheat is a slow process. It takes years and years, and many are the disappointments. Many varieties were produced that were rust resistant, but they were weak-strawed, or not resistant to drought or produced yellow flour or were not good bread-making wheats; therefore they had to be discarded, and so the work went on.

Finally there emerged in quick succession four epoch-making rust-resistant varieties, namely, *Renown*, *Regent*, *Thatcher* and *Apex*.

Renown was developed at the Dominion Laboratory of Cereal Breeding in Winnipeg. It is high in weight per bushel and flour yield, is equal to *Marquis* in yield per acre, and most important of all has proven highly resistant to stem rust and stinking smut, and moderately resistant to leaf rust. It is a first-class wheat.

Regent, also developed in Winnipeg, is a very promising rust resistant wheat. It is a higher yielder than *Renown* or *Apex* and superior to them in resistance to leaf rust. It was first distributed in 1939 and is proving popular, particularly in Manitoba.

Thatcher is a wheat that has been developed in Minnesota, where it was released in 1934. It is a heavy yielder but is susceptible to leaf rust. It now occupies one-half of the acreage in Canada grown to wheat, and is a very popular variety.

Apex was developed at the University of Saskatchewan. Its yield is equal to *Marquis* and it is more stem rust resistant. Unfortunately, it is susceptible to leaf rust. It is one of the promising new wheats, grown chiefly in Saskatchewan.

Redman is one of the latest varieties developed at the Dominion Laboratory Winnipeg. Dr. C. H. Goulden, head of the laboratory, says *Redman* wheat has been in the process of development for the last twelve years. It is highly desirable in regions susceptible to rust because of its resistance to leaf as well as stem rust. This makes it a better wheat than *Thatcher* where leaf rust is prevalent. It excels *Regent* because it withstands drought conditions somewhat better. This is a splendid wheat, and if it develops as it promises to do will mean millions of dollars to Canada. Approximately 15,000 bushels will be available this Spring (1947). Once again, the experimental laboratories and stations have proven their value to Canadian agriculture.

For many years scientists have been seeking a wheat that was resistant to wheat stem sawfly. At first glance it seems impossible to produce such a wheat, yet such has been done, and a wheat capable of such resistance to a high degree has been developed at Swift Current. This wheat is known as *Rescue*. In addition to being resistant to wheat stem sawfly, it is resistant to stem rust, but it is susceptible to leaf rust and bunt. In yielding qualities it is lower than *Thatcher*, but where damage from sawflies is great it is definitely superior.

The sawflies have become such a pest that it is estimated that as much as 50,000,000 bushels have been lost from a single crop. Scientists are seeking other methods of controlling this terrible plague.

Rescue, however, is far from perfect. It lacks in absorption ability, and cannot be graded higher than No. 3 Manitoba Northern, which detracts from its commercial value. It is interesting to know that in the fall or autumn of 1944 two bushels of this wheat were given to the United States and went to the Montana State College at Boseman. It was rapidly multiplied (being grown in Arizona in the winter months), and was also tested carefully at Boseman. Now the Americans have 65,000 bushels

and expect to grow *Rescue* in their areas where sawflies are a dreadful pest. This variety will mean millions of bushels of wheat will be grown where wheat was a partial failure due to this detestable sawfly.

Enough has been said about the developments in wheat, particularly the development of varieties possessing all the good qualities of Marquis, and, in addition, being earlier in maturing and highly resistant to stem rust, leaf rust and sawflies.

The work continues. New varieties will, after ten or fifteen years of experiment and testing, be released to the benefit of mankind. Tribute should be paid to Dr. L. H. Newman, Dominion Cerealist, Dr. J. H. Craigie and Dr. C. H. Goulden of Winnipeg and their associates in experimental farms, laboratories and agricultural colleges, for long years of hard, and in some cases, disappointing work. But through their effort the area devoted to the production of "the staff of life" has been doubled in Western Canada and the losses suffered through the various rusts, smuts and various pests, have been curtailed in volume to an extent that means a saving of hundreds of millions of dollars to Canada.

Oats.—The oat crop of Canada is of importance, second only to wheat, and improved varieties have been developed that are very resistant to rust fungi, both to various stem rusts and leaf rusts. I do not propose to go into details here, but simply to say that the variety of oats known as *Banner* has been superseded by such varieties as *Vanguard*, *Ajax* and *Exeter*, that are of excellent yield, good quality, and are in part at least resistant to rust.

The *Erban* variety of oats was produced by the Ontario Agricultural College by crossing *Early Ripe* and *Banner*. It was partially resistant to crown rust. Then *Erban* was crossed with *Vanguard* and produced *Beaver*, that is resistant to all the stem rusts that *Vanguard* is resistant to and to all the crown rusts that *Erban* resists. *Beacon* is another good new variety and will replace *Beaver* in many sections on account of its greater rust resistance and stronger straw.

The same hard work has been done with oats as with wheat by scientific workers and with excellent results.

The Dominion Rust Research Laboratory at Winnipeg has just announced a new variety of oats resistant to all kinds of stem and crown rusts that appear in Canada. This variety is called *Garry*, after old Fort Garry, the original headquarters of the Hudson's Bay Company of fur traders. They have been working on it since 1932. If successful, it will add to the many triumphs of this laboratory and will mean millions saved to the farmers of Canada.

Barley.—Canada produced 160,000,000 bushels of barley in 1946 and care is being taken to produce a high yielding, high malting variety. At the same time, it must be kept in mind that mildew injures the barley crop quite seriously in some areas, therefore breeding for mildew resistance is essential.

Good malting barley in Canada is always six rowed, not two rowed as in England. The standard variety up to now has been *O.A.C. 21*, a rough awned barley. After 24 years of careful work a new smooth awned variety, named *Montcalm*, has been developed by Professor E. A. Lods of MacDonald College. Professor Lods is a classmate of my own, and I have great respect for his work.

Experts think that *Montcalm* will prove of great value to farmers and brewers, and is an important development in Canadian agriculture. One journal says:

"The main advantages of *Montcalm* over other types of malting barley are its greater yield and better malting qualities. Actually, *Montcalm* is superior to the standard *O.A.C. 21* in yield of heavy grade barley, slightly higher in kernel weight, and definitely lower in nitrogen content, which is a desirable feature. Its behaviour in malting is very similar to *O.A.C. 21*, so mixtures of the two varieties, such as might occur in commercial shipments, would create no difficulties in malting. *Montcalm* is superior in quantity and quality of malt extract. All these points indicate that, in *Montcalm*, Professor Lods has made a worthwhile contribution to the malting industry". So, after a quarter of a century of faithful endeavour an important new malting barley has been produced.

While considerable barley is used for malting purposes in Canada, yet it is as a feed for livestock that barley is most highly prized. Plant breeders, therefore, have devoted much more time to the development of superior varieties of this type and with excellent results. Two outstanding varieties, *Plush* and *Vantage*, both rust-resistant, have been developed at Brandon; *Prospect* has been introduced by the Swift Current Station, Saskatchewan; *Titan* and *Sanalta* by the University of Alberta; and a promising mildew-resistant type is being developed at Ottawa.

Time does not permit of mention being made of the work done with flax field beans or field peas. These are important crops in Canada and excellent varieties are now available thanks to the plant breeder.

Horticulture

In some respects the storage and particularly the gas storage of fruit, apples in particular, is more advanced in Britain than in Canada, so all credit must be given to private enterprise and public research stations in this country.

Much work has been done in all countries in perfecting new varieties, and in particular, producing strains that are resistant to disease.

Raspberries and strawberries.—Canada produces considerably fewer strawberries and raspberries than the United States—some 16 million quarts of strawberries and about 12½ million quarts of raspberries. These small yet important crops were threatened with extinction by two virus diseases, mosaic and leaf curl. These have been controlled and healthy stock has been provided through the work of experimental stations and other government agencies. New varieties have been produced which were resistant to these diseases.

Apples.—This forms an important crop, particularly in British Columbia, Nova Scotia and Ontario. Canada produced over 16 million bushels last year, several shiploads being sent to Great Britain in recent months. During the war years, however, this market was cut off, and so much work of an important character has been done in the dehydration of apples, and the packing of apples without sugar. There has also been an enormous increase in the consumption of pure apple juice, as opposed to cider.

Excellent research work has been done on the vitamin content of various juices, such as apple and tomato, and also in sulphuring methods of packing strawberries and loganberries.

Peaches.—Peach-growing was threatened by disease, peach canker and brown rot being two diseases that were present. Canada produces over two million bushels of

this delicious fruit in two provinces, Ontario and British Columbia. Control measures were taken and a pre-harvest sulphur spray or dust almost completely eliminates brown rot. Tests are continuously being made with new fungicides and insecticides. Great credit must be given to the Dominion Horticulturist, the Dominion Botanist and their many associates at Federal and Provincial stations.

Potatoes.—This crop, which is of importance in so many countries in the world, is of special importance in Canada, due to the fact that she produces large quantities of seed potatoes for export. In 1946, Canada produced 36 million hundredweights worth $75,000,000. Most of her select seed potatoes are produced in two provinces, New Brunswick and Prince Edward Island. Time does not permit of more than mentioning that scientists are working on and controlling mosaic diseases—leaf roll, and late blight—and are also developing varieties that are more resistant to these diseases, heavier yielders and better quality, as well as varieties that are resistant to a few degrees of frost.

Tomatoes.—Excellent work is being done on tomatoes at Ottawa, Ontario, Summerland, B.C., and Kentville, N.S. Tomato juice is a very popular food drink all over North America.

Tobacco.—Very few people in this country realise that Canada is a heavy producer of fine quality tobacco. She produces this in three provinces, Ontario, Quebec and British Columbia, but over 90 per cent. of it is produced in Ontario. The Canadian crop this past year is estimated at over 134,000,000 lb., of which about 50,000,000 lb. will be used by Canadian smokers. This compares with a production of 76,000,000 lb. in 1938.

The bulk of Canadian tobacco is fine quality, flue-cured, used largely for cigarette manufacture and in pipe blends. Britain would like to import more of these tobaccos.

Much has been done in producing early varieties, and varieties that are resistant to black root rot, brown root rot, mildew and the horned ear worm. There are two tobacco research stations in Canada.

The Prairie Farm Rehabilitation Programme

One of the most important of the recent agricultural developments in Canada has been the rehabilitation of prairie agriculture during the past twelve years.

Along with a remarkably fertile soil in the three Prairie Provinces, goes scanty rainfall. The average rainfall at Winnipeg is about 20 inches, while it is as low as 13 inches per year in parts of Alberta. This compares with 30 to 40 inches in Eastern Canada, and with 33 inches in England. The story is told of the traveller who asked a certain Saskatchewan farmer "How many inches of rainfall have you in your district"? To which the farmer replied "Oh, about 15 inches, I well remember the night it fell". This, of course, is not literally true, although we do have some violent rain storms on the prairies. Rainfall generally is insufficient to maintain a high water table in the soil which might be tapped by shallow wells. Therefore, to secure reliable supplies of water it has been necessary for many farmers to incur the expense of sinking drilled wells, or of creating artificial reservoirs by damming streams or excavating dugouts.

There are approximately 65 million acres of cultivated land in the Prairie Provinces besides many million acres in grass and unimproved areas. Of this area 20 million

acres are devoted to summer fallow. This fallow land is (*a*) to conserve soil moisture, and (*b*) to control weeds.

In the year 1930, the Prairie Provinces entered a period of economic depression and severe droughts. The depression was inaugurated by the memorable stock market crash of the previous year. This was disastrous to the wheat grower, and for the nine-year period from 1930 to 1938 inclusive, the average price of farm wheat was only 55 cents per bushel, compared with 92 cents for the preceding nine years. This was a ruinous price for the farmer, for the price of commodities that he had to buy did not fall to this low level.

Prolonged drought aggravated soil drifting and caused crop failure, so in 1935 the Dominion Government took action and passed The Prairie Farm Rehabilitation Act, or the P.F.R.A., as it was soon called.

The Prairie Farm Rehabilitation Programme, which has been in effect for just over twelve years, has three main objectives:

1. *Cultural.*—To secure the adoption by farmers of such tillage and cropping practices as will enable them to farm successfully under a wide and fluctuating range of physical and economic hazards.
2. *Land Utilisation.*—To divert crop production from poor land, and to use such land for grazing. It is recognised that a great deal of sub-marginal land is being cultivated that should go back to grass.
3. *Water Development.*—To make better use for agriculture than formerly of the water resources of the prairies.

The Dominion and Provincial Governments went into action and great success has attended their efforts. The Experimental Farm Service was of the very greatest assistance. A head office was established at Regina, and much thought and direction was given to research and the encouragement of better farming methods. Demonstrations were given, and the farmers took hold with a will.

For example, the P.F.R.A. programme and the experimental farms have been directly responsible for the re-grassing work on some 300,000 acres, but farmers individually have re-seeded very much more.

Research proved that a new grass introduced from Russia called *Crested Wheat Grass* was the best cultivated grass for use on dry land. The *Fairway* variety selected by the University of Saskatchewan is highly recommended.

Tree planting has been encouraged. Soil research has been carried out and soil surveys have been made.

Community pastures have been organised, varying in size from 4,000 acres to 170,000 acres. They comprise 1,500,000 acres of sub-marginal land. Many farm families have been moved to new and better locations to make the community pastures possible. Water is provided in all these pastures and improvement in the grade of cattle is brought about by the use of selected pure bred bulls.

Several millions of dollars have been expended in water development projects, large and small. From new irrigation projects which will aggregate 168,000 acres of land, to small stock-watering dams which are built by the farmers with some assistance, a great deal has been accomplished. 23,800 projects have been completed and the work is increasing yearly.

FOREST IMPROVEMENT

Canada is very wasteful of her splendid forests. Apparently, the men in charge of lumbering and logging operations think that there is an inexhaustible supply, which is not true. Some lumber companies look upon the conservation policies followed by Sweden, Norway, Germany (before the war), Great Britain and even little Denmark with approval.

As the Department of Agriculture devotes much energy to the control of forest insects, I have included the forests under the heading of agricultural developments, although they are not included in pure agriculture. The discovery of white pine blister rust in Ontario about 30 years ago created the first major interest in forest pathology in Canada. It has been controlled but not eradicated. Since then the battle of the Spruce Sawfly has been fought and won. In 1930, the outbreak was most serious in New Brunswick and Maine, and in areas in Quebec. The sawfly was costing Canada millions of dollars per year, but after long search a virus disease was found that practically wiped out the sawfly and saved Canada her spruce forests.

ANIMAL HUSBANDRY

Nothing very spectacular has been done in animal husbandry lines yet substantial progress has been made in all classes of live stock.

Horses.—The greatest progress has been made in improving the type of the Belgian breed. They have vastly improved in quality, particularly of feet and legs, and still retained weight, strength and draught power. This breed now stands second in popularity in Canada to Percherous as far as licensed stallions are concerned.

Beef Cattle.—Probably the greatest improvement in beef cattle has been witnessed in the Hereford breed. This famous old breed of cattle, named after one of the many beautiful counties of England, has improved to a marked degree in the lands of its adoption, both in Canada and in the United States. The cattle have improved so much in type and conformation that their breeders claim they have better animals now in North America than are found in the land of their origin.

It is probable that a few more outstanding individual specimens can be found in Western England than can be found in North America, such as the marvellous bull, "Vern Robert", owned by Captain De Quincey near Hereford, but the number of *good* Herefords is much greater in Canada than in the United Kingdom. With a sale of 1,000 pure bred animals, Calgary, Alberta, claims to have the largest bull sale in the world.

Dairy Cattle.—Breeding of dairy cattle has reached its highest developments in the Province of Ontario, although the other provinces are not far behind. This has been characterised by the production of cows giving very large yields of milk and still retaining type and constitution.

The most popular breed with us is the Holstein-Friesian, which is akin to the British Friesian, the Canadian animal being more of a specialised milk-producing machine. The largest record made by an Ontario cow is 35,207 lb. of milk, or 3,520 gallons, in one year. A splendid record was made by a British Columbia cow with 34,646 lb. or 3,464 gallons of milk. Recently a great record was made by an Alberta Holstein which produced 27,745 lb. of milk containing 1,409 lb. of butter fat, with 5·08 per cent. milk, in 365 days.

In Ayrshires (so popular in Quebec and Ontario) records have been made of over 31,100 lbs. of milk, or 3,110 gallons, containing 1,300 lbs. of butter fat with 4·35 per cent. milk. Large records have been made by Jerseys and Guernseys, both in Eastern Canada and in British Columbia, with milk testing up to 6 per cent. butter fat.

Sheep.—Sheep are not very numerous in Canada, but a new breed of sheep is being developed by the University of Saskatchewan. This breed, it is hoped, will be particularly suited to the open range. Canadian ranches desire a sheep that will withstand cold and snow as well as summer heat, produce excellent clean wool, free from black fibre, and also produce good mutton. Experiments have been carried out using Targhee rams on various crosses of Rambouillet, Corridale and Ryeland breeding. Much work remains to be done, but results so far are encouraging.

Swine.—In pigs, Canada has specialised exclusively in Yorkshires, or Large Whites as they are known in Britain. Private breeders and public institutions and stations have vastly improved this breed. In fact, Canadians claim that the best bacon in the world is being produced from these pigs. My Danish friends will probably not agree, but the fact remains that Canadian bacon has vastly improved during the past ten years. The stupendous increase in shipments of Canadian bacon to Britain will be touched on later.

Under the Production Service of the Department of Agriculture, the study of "Advanced Registry in Swine" has a marked influence in the selection of better strains within the Yorkshire breed. The development of these desirable strains of pigs will still further improve our swine and will produce earlier finishing pigs and better sides of bacon. A vast amount of research in animal nutrition has been done by agricultural colleges.

Very important progress has been made in artificial insemination in Canada during the past decade. This has been in line with developments in Russia, Great Britain, Denmark and the United States. Everywhere this is coming into more general use, particularly in the case of small farmers who cannot afford to keep a choice pure bred bull with good records behind him.

Animal Health

Canada, by rigid restrictions and competent inspection, has kept two very much dreaded diseases from her borders namely, *Foot and Mouth Disease* and *Hog Cholera*. The first is guarded against from Great Britain and Europe and the second from the United States.

Great progress has been made in reducing the incidence of Bovine Tuberculosis in Canada. Whole provinces now being "Restricted Areas", or "T.B. Free Areas", as they are popularly known. This partial freedom from this disease is attained by three schemes of attack carried out in the main under the direction of the Veterinary Director General. They consist of—

(*a*) Restricted Areas or T.B. Free Areas.

(*b*) Accredited Herds (mainly pure bred cattle).

(*c*) Supervised Herds (mainly dairy cattle).

Time does not permit of more than mentioning these schemes save to note that they are bringing results, and that within an appreciable time all the cattle of Canada will be tested.

Other diseases are being dealt with with reasonable success, and the health of Canadian live stock is remarkably good.

FARM ORGANISATIONS

During fairly recent years there have been great developments in the field of organisation of farmers for their mutual benefit.

Co-operation has grown by leaps and bounds. These growths have been local, provincial and national in their character and have been evident in all provinces, from the co-operative movement of St. Francis Xavier University of Antigonish, Nova Scotia, to the co-operatives in milk production and vegetable growing of the Fraser River Valley, British Columbia. In this movement the Prairie Provinces have perhaps been most active. These local efforts have resulted in the powerful wheat pools of Saskatchewan, Manitoba and Alberta, the Farmers' Co-operative of Ontario and similar organisations.

Along with Co-operatives, we find the development of Farmers' Associations which resulted in the U.F.O. government in Ontario, the U.F.A. government of Alberta, and, at the start, in the C.C.F. political movement in Dominion and Saskatchewan fields. In the case of the C.C.F. (Co-operative Commonwealth Federation) they have recently combined with certain labour groups, and by some are considered to be Socialist.

The U.F.O. and U.F.A. governments have come and gone, but farm organisations have developed a national body which is held in much regard in Canada, namely, the Canadian Federation of Agriculture.

The C.F.A. has its headquarters in the national capital, Ottawa, and, is in many respects, similar to the National Farmers' Union of England and Wales. It is a recent agricultural development of great importance. It is listened to with respect by the Government of Canada, speaking as it does with authority as representing such a numerous and influential class as the farmers of Canada.

GROWTH IN FOOD PRODUCTION AND MARKETING

As the war progressed, a real and genuine effort was made to help the Mother Country by the greatest possible production of food. It was realised by all agricultural interests that Britain must be fed, that Canada was closer to her than South Africa, Australia or New Zealand, and that economy in shipping demanded shipments from North Atlantic ports rather than longer journeys from the Pacific or the South Atlantic, such as from Argentina or South Africa.

Canada was fortunate in having two of the best railway systems in the world. The Canadian Pacific with its 17,000 miles of railway and its steamship lines, is called "The World's Greatest Travel System", and the Canadian National Railways, with its 22,000 miles of railway in Canada, is the largest railroad system in the Western Hemisphere.

With these two good railway systems to depend on, Canada shipped immense quantities of wheat and flour, bacon and beef, eggs and poultry, cheese and dried milk, and other foods to the seaboard and to Britain.

But before they were shipped an enormous amount of work was done by the various boards appointed by the Government of Canada, such as the Agricultural

Food Board, the Agricultural Supplies Board, the Meat Board, the Special Products Board, the Dairy Products Board, and others. A tremendous burden was placed on the members of these boards, the farmers of Canada, the processing firms (such as packing plants), the railway companies and the shipping concerns.

In the case of beef, Canada shipped practically no beef at all to Britain in 1938, yet last year she exported to the United Kingdom 170,000,000 lbs. of frozen beef.

When one considers that the shipment of bacon and hams to Great Britain rose from 180,000,000 lbs. in 1938 to 700,000,000 lbs. in 1944, and realises the enormous increase in production of hogs, the increase in the processing and packing, the increased use of refrigerator cars and the labour involved, it is surprising that it could be done.

The export of eggs from Canada increased from a few thousand in 1938 to 800 million eggs in 1946. The production of cheese increased from a little over 100 million lb. in 1938 to 185 million lb. in 1945, and the production of evaporated milk increased from a small quantity in 1938 to a very large amount in 1945. And so, all along the line (save in wheat), the increase has been phenomenal.

This marked increase in food products was a tribute to the farmers of Canada, and a most important agricultural development.

Agricultural Conservation

Much of this has been referred to under the Prairie Farm Rehabilitation Programme, and this Act may be extended to all of Canada. One evidence of this is the provision of assistance in co-operation with the Provinces of Nova Scotia and New Brunswick, to enable the reclamation of much rich land that requires protection by dykes. This will require the expenditure of effort and money, and is under way.

Another evidence of conservation is in the Province of Ontario, where steps are being taken by the Province, assisted by the Federal Department in the Ganaraska watershed area, where land has been abandoned and now is being conserved.

Soil conservation, forest control, water development and wild life protection are receiving immediate attention.

Agricultural Immigration and Settlement

A development awaiting solution is the problem of immigration, particularly as it affects agricultural workers. The consideration of the refugee problem, the unrest and desire of Europeans to migrate has received serious consideration.

It may be assumed that a considerable number will settle on the farms as well as in towns. British, Scandinavian and Dutch settlers are favourably received in Canada, but many others are welcome. The admission of a good number of Poles has created a good impression and indications are that others will follow.

The farmers of Canada need more help on the farms and good farm workers are scarce. Canada needs increased population of the right type.

Soil surveys have been made to determine how much land suitable for farming remains uncultivated. It is considerable, but is not nearly as extensive as is sometimes supposed. One authority says 25,000,000 acres, others say more, a number say less.

A Committee of the Senate has conducted an investigation during the past year

into land use and immigration, so we can definitely say that this important development is receiving attention and the flow of immigrants will be directed into the proper channels.

Mechanisation in Agriculture

Canadian agriculture, which has always been highly mechanised, continues to expand. Farmers are making plans to acquire a great deal more equipment. Surveys made by the Agricultural Economics Division of the Department of Agriculture in co-operation with provincial authorities, indicate intentions on the part of farmers to purchase hundreds of millions of dollars' worth of new equipment in the next few years. Major interest is centred on such machinery as combine harvesters, tractors, farm trucks, milking machines and all types of power equipment.

Development of Agricultural Industries

During the war, Canada was forced to develop her agricultural industries, not only the ones already established, but also new ones. For example, when Britain could not take a large portion of the Canadian apple crop, private enterprise aided by the Dominion Government came to the assistance of the apple industry by the development of dehydration, and the manufacture of apple products and juices, also by providing guaranteed prices. The same applied to dehydration of vegetables, eggs and milk. The future success of these industries is not settled, but we hope that they will continue to prosper. Some adjustments will have to be made.

Conclusion

I must now of necessity draw this review or lecture to a conclusion. Many points have not been touched upon, but I think that the more important developments along scientific research and economic lines have been pointed out.

Undoubtedly, the development of rust resistant varieties of wheat, oats and barley has been of the utmost importance.

The record of achievement in the rehabilitation of prairie agriculture during the past ten years is encouraging. The knowledge gained by research of insect control in cereals (as in the case of sawfly resistant wheat), of control of forest pests, and of animal diseases is encouraging. The new records made in cattle, swine and poultry breeding are of the very greatest value.

Economic changes have taken place and have been resolutely faced. Plans have been made to deal with them.

Due to public and private co-operation, a grand effort has been made to produce a vast increase in food when the need was the greatest, so that Canada can feel satisfied that great progress has been made in recent years. Much remains to be done, and we do not claim any monopoly in development along agricultural lines, but give every credit to other nations, particularly the English-speaking countries.

DISCUSSION

Mrs. McWharrie: I should like to ask what is the policy in regard to the type of people Canada wants for the farms. Do they want skilled tractor drivers and skilled mechanics and specialists?

Lieut.-Col. J. G. ROBERTSON: I think they want both types, but generally speaking they want people who are skilled in farm work. They want horse drivers and tractor drivers and a lot of people with skill in other work, but they can take a certain number of people who are unskilled. I think, however, that they prefer people who are expert along agricultural lines.

Mr. H. S. BARNES: Is there any record of deterioration of the soil in Saskatchewan as a result of the concentrated growing of wheat on the same soil? Also, what steps are being taken to prevent soil erosion and destruction of the countryside?

Lieut.-Col. J. G. ROBERTSON: There is considerable danger of deterioration on the prairie farms particularly if you get periods of drought. So long as there is plenty of rainfall the farms will produce large quantities of wheat, oats and barley, but in times of drought you have to watch out for soil erosion. To fight this is one of the objects of the Prairie Farm Rehabilitation Programme. They encourage strip farming and the turning in of humus into the soil and are trying to get farms away from the sub-marginal lands which should never be devoted to the growing of wheat but the pasturing of cattle. A great deal of attention has been given to the prevention of soil erosion in recent years.

Mr. A. D. HARPER: The subject of tobacco has been receiving a great deal of attention in this country. Is it possible for Canada to expand the volume of her production of cigarette papers and tobacco to any great extent?

Lieut.-Col. J. G. ROBERTSON: We have increased the production of tobacco from 75,000,000 lb. to 134,000,000 lb.—that was last year—which is a very decided increase and I think that a still greater increase could be brought about, but there are limiting factors. There is only a certain amount of land in Canada suitable for tobacco production, largely in Ontario. There is a certain amount of tobacco raised in Quebec and, without casting too much reflection on Quebec tobacco, it is not of first quality! There is also a certain amount of tobacco grown in British Columbia. I think that tobacco production probably could be doubled in Canada provided the price was satisfactory and if due care was taken in its growth and development.

Sir HERBERT HOWARD: I should like to revert to the question of soil erosion in these vast wheatfields. Continuous cropping of wheat, heavy rainstorms followed by dry periods produce conditions favourable to that insidious form of erosion, sheet erosion. Is anything being done to watch for that and check it?

THE CHAIRMAN: I think I can say that both Canada and the United States had a very bad fright twelve years ago when the dust bowl came out. Fortunately we only had the northern rim of it, but it spread right down to Oklahoma and threatened the farms west of the Mississippi. There has been a survey carried out both in the United States and in Canada in close co-operation, and techniques and results have been exchanged. I think the agricultural services are very much alive to the risk to their economies if there is any continuation of the critical conditions which developed in the 1930's.

I do not think there are any steady winds of great strength which might be a factor in soil erosion, although after the great droughts of the middle 'twenties the major erosion in the prairies in the south-west was wind erosion and there were periods when for weeks and months, over a range of 1,000 miles, the air was darkened by small particles of earth in suspension.

Mr. ALFRED DAY: I should like to ask why the lecturer omitted any mention of sheep in his paper. Is the climate unsuitable for sheep in Canada? We had hoped that in time we should get some increased exports to Canada. Also, would not sheep be one answer to the question of soil erosion?

Lieut.-Col. J. G. ROBERTSON: I had a paragraph about sheep in my paper, but owing to pressure of time I left it out. Sheep are not produced in great numbers in Canada; we only produce 3 to 3½ million. That does not compare very favourably with New Zealand with 33 million or Australia with 106 million. But sheep production is being advocated in Canada to quite an extent and, as Mr. Day said, if Canada would produce more sheep and more livestock generally it would be better for the country. We should very much like more sheep, but the production of wheat is the easiest way to farm a large

part of the prairie provinces and the land there is ideally suited to wheat production. That land produces the best wheat in the world and man is a gambler and he gambles on the fact that he thinks there will not be a drought this year and that he will get a good crop.

As the Chairman said, in the 1930's we had a series of dry years. During the past seven years we have had a series of years of ample rainfall and we have had large crops of wheat. Probably climatic conditions move in a sort of cycle so we are liable to have a return of dry conditions some time or other within the next few years. That is one reason why the Canadian Government and the agricultural colleges are advocating the production of more livestock and the production of less wheat. There are other reasons as well, of course. They look to the time when there will be a surplus of wheat in the world when the price will go down, but certainly the production of more livestock is being advocated and sheep is one class of livestock which Canadians would be wise to develop to a greater extent than they do. They cannot compete with Australia and New Zealand in the production of lamb and mutton and wool, however. Nevertheless they could produce more sheep than they do, particularly for home consumption.

Professor ROBERT RAE: I have a question to ask, but before doing so I should like to say that I had the opportunity during the war of going all over Canada and seeing a considerable amount of the farming of that country. I should like to add my small tribute to the tremendous efforts which the farmers of Canada made in food production during the war years and to the fine work done by the Government's experimental farms in dealing with national and local problems.

Perhaps Colonel Robertson would give some further details to something which he referred to in answering a previous question, namely, strip farming as an answer to the erosion question. I remember being on a farm of 2,000 acres near Calgary which was both a cattle and wheat farm, and no area of wheat in that farm was more than 25 acres. There were 25 acres of wheat, 25 acres of stubble, 25 acres of wheat and so on.

I take it that a great deal of the increase in livestock, particularly pigs, has taken place in the prairie provinces as well as in the eastern provinces. Is that increase of livestock likely to remain in the prairie provinces or are the farmers there going back to wheat rather than livestock?

Lieut.-Col. J. G. ROBERTSON: With reference to strip farming that simply means what the name implies, that you have a field running at right angles to the prevailing wind and you have a strip of summer fallow consisting of about 25 acres and then a strip of wheat, then a strip of summer fallow again and a strip of oats or barley. Thus the winds do not get a sweep at that large field which they otherwise would. If it were all summer fallow there would be a cloud of dust going over the prairie, but by the use of strips that is prevented.

With regard to the question as to whether the prairie provinces are going back to wheat growing and abandoning stock raising, that is rather a difficult question to answer. They did make a splendid effort during the war to increase the production of beef cattle and hogs, particularly in Alberta. I think that you will see quite a number of cattle, hogs and poultry raised in the prairie provinces but, of course, the answer depends partly upon what the price of wheat will be. If it is high and the price of livestock is not so high, the tendency will be for the farmer to go in for the production of wheat, but if the price of wheat goes down he is surely going to turn to livestock, and for that reason the Dominion Government at the present time is paying a bonus for the production of barley. They want to encourage its production and discourage the production of wheat. By producing barley they will get more feed for livestock and more hogs and cattle to eat it. Every effort is being made to balance agriculture and avoid the production of too much wheat. But the world price of wheat in the next few years will be a very important factor. There has been a decrease in the number of hogs raised on the prairies and I do not look for much increase this year. There will be an increase in Eastern Canada.

Mr. ALFRED DAY: Can we expect any larger imports of fruit? Are the fruit farmers going to send us more whether we can pay for it or not?

THE CHAIRMAN: There has been no increase in the orchards. In the first year of the war there was an acute problem in the provinces which produced fruit, but developments in methods of processing have increased the domestic utilisation of tree crops generally and the producers have managed to pull through satisfactorily. There is no doubt that the Canadian fruit growers have always looked to the United Kingdom as their most important market and we hope that the general economic policy our Governments are pursuing will reach a happy state of equilibrium and that you will get better apples from Canada cheaper than from anywhere else.

Lieut.-Col. J. G. ROBERTSON: There are three provinces in Canada where apples are raised in large quantities, namely, British Columbia, Nova Scotia and Ontario. Of those provinces Nova Scotia is the closest to Britain and Britain should be its market. There has not been any great increase in apple planting during the past few years. In fact, during the war the growers wondered what they were going to do with their apples. They could not eat them all and they could not ship them over here. However, they have large quantities of apples that are for sale at the present time and they are coming to Britain. You do not see many in London, but you see them in Glasgow and Liverpool. As to whether you will pay for them or not, that is not really a question for me to answer. But I think that the production of fruit will increase in Canada, particularly the production of peaches, and some people are looking into the question of shipping peaches by airplane from Canada to Great Britain. They may be cheaper even that way than peaches are here at the present time.

Mr. W. A. POOL: I should like to pay a tribute to the animal health situation in Canada. It is unique and is not only due to geographical position but to the foresight of the people responsible in past generations. As Colonel Robertson emphasised, there is no swine fever and the country is free from other serious diseases that are prevalent in many countries.

For a number of years early in this century Canadian animals were accused of having a very bad scourge, bovine contagious pleuro-pneumonia, and an embargo was placed on importation of Canadian animals into Britain on that account. This embargo might well have been removed many years before in fact it was, because that disease was absent from Canada, at least during most of the time of the embargo. The National Veterinary Medical Association of Great Britain and Ireland, discussing the control of tuberculosis, pointed out recently that one of the hindrances to progress in this work in the United Kingdom is the replacement of the infected animals taken out of the herds, and suggested that Canada might be a source of supply if she could provide the animals. Some dairy cattle have come over and met with approval.

THE CHAIRMAN: I should like to propose that we thank the lecturer for his very comprehensive and informative survey of the main developments in a very big field over recent years. Those who have contributed to the discussion from the floor have added to the interest of the meeting.

The vote of thanks was carried with acclamation and the meeting terminated after a vote of thanks had been accorded to the Chairman, and the lecturer had personally thanked Mrs. McWharrie for having made his lecture possible.

GENERAL NOTE

EXHIBITION OF "DEEP PICTURES".—A very interesting exhibition of three-dimensional photography was held at the London Exhibition Centre recently. On view were a number of flat photographs which give to the spectator a very effective three-dimensional impression of various subjects without the use of any of the apparatus used with ordinary stereoscopic photography. So effective is the illusion of depth, that

one has the impression of looking at a sculptured model; one can even appear to put one's finger behind an apparently protruding part of a picture.

The process operates with the help of ordinary photographic materials, with the addition of a grid comprising a special lenticular optical system, and the prints are apparently only slightly more expensive than orthodox first-class studio pictures. The photographs on view illustrated a variety of subjects ranging from studio portraits to microphotographs of insects and wrist watch movements.

The applications of this new invention may be wide. Quite apart from its use for popular illustration, it will, on the commercial side, provide a means of carrying a complete exhibition of any types of sample in a very small space, or of widely demonstrating new designs or fashions. Medically and educationally it has great possibilities in the demonstration to students of such things as the phases of a new operation or the details of plants and mineralogical specimens. One's imagination can easily run riot at all its fascinating possible applications.

CORRESPONDENCE

Economic Reconstruction

Any series of lectures on reconstruction is incomplete without reference to the basic importance for the people of healthy food, homes and home interests. These three needs can be best provided for by the development of the independent family smallholding, all the organic wastes therefrom, including human waste, being put back into its cultivation.

In South Africa the Departments of Education and Agriculture jointly run Agricultural Clubs for country children. The children take approximately one-acre plots on their parents' farms, which they cultivate in their spare time in Union-wide competition with strong emphasis on organic fertilising. Last year's prizewinner in the maize contest grew forty 200-lb. bags of maize on his half-morgen (1 1/20 acres). The competition average yield was twenty bags against the commercial farming average of between two and two and a half bags. Results in poultry keeping, animal husbandry and vegetable growing were similar.

Is it possible that the British people could grow all the foods they need—apart from those for which their climate is unsuitable? Could not the economic system be modified to allow each individual the land to develop himself? An immense amount of re-education would be necessary to show both how to develop the land, and the value and advantages of husbandry as a happy and creative leisure pursuit. There is surely great scope for this as a pastime in the rapidly increasing leisure hours available to the British people.

Transvaal. FRANCIS H. SIBSON.

Fuel Economy

It is the duty of everyone to try and help in suggesting any constructive means which will ameliorate the Coal position, and I would like to put forward the following suggestion relating to the improvement to city streets' and highways' lighting by use of diffused illumination.

During the last war we all experienced with some concern the indirect illumination over large areas where searchlights were manœuvred, and there seems no reason why a cluster of mobile powered searchlights could not be erected off the local electricity supply on, say, the roof of a high building or structural tower, or on local heights, so that horizontal beams from them would not be obstructed by any building in the vicinity.

With this method of lighting the features of both the direct and indirect systems are contained. Light from the beams passes downwards and upwards, in the latter case being reflected by any low-lying clouds and thus diffused throughout the area. Clusters erected in the centre of a city or at suitable points, say about five miles apart, might give sufficient light to produce a soft and pleasing illumination.

If it were possible that a few searchlight units could be collected from the vast number redundant and tried out, the results might prove to be very interesting, especially if the beams happened to be above the height of a local fog.

CLAUDE L. JACKSON.

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MODERN APPLICATIONS OF PHOTOGRAPHY

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CANTOR LECTURES

LECTURE I.—*Delivered May 5th, 1947*

AIR PHOTOGRAPHY

All our economists are agreed on one point, namely, that one of the most vital problems confronting the British people—a problem that must be solved if social security is not to remain a pipe-dream and the standard of living is to rise rather than fall—is to bring about a great increase in national efficiency by the raising of national productivity, both in volume and quality. I believe that photography in its many forms will be an indispensable tool in achieving this object.

Unfortunately, man is on the whole intellectually lazy, and it is a sad thought that only under the primitive stimulus of war does he usually muster the collective will and energy to apply available knowledge to achieve his aims in the shortest possible time. The major contributions photography made to victory depended not so much on basically new discoveries in the range of photographic technique as on the effective harnessing on an adequate scale of techniques whose potential value was known in 1939. This thesis is well exemplified by the recent history of air photography.

In 1940 a remarkable organisation was built up in Britain for collecting by air photography information about the day-to-day progress of our enemies' war effort. This organisation—the Photographic Reconnaissance Units and the Central Interpretation Unit—was responsible for obtaining the majority of the intelligence information we received from Occupied Europe after the fall of France.

When the Allies have got sufficiently tired of maintaining occupation armies in Germany it is to be expected that they will recall how successfully we kept an eye on Germany by the far cheaper and more convenient technique of photographic reconnaissance. In conjunction with a small group of specialists on the ground it is quite capable of ensuring that no major industrial or warlike activity takes place in Germany without our knowledge.

That aerial photographic reconnaissance would be an important source of information was, of course, recognised before the war, but few, even of those

intimately concerned, realised before 1941 the remarkable results that could be obtained by a combination of first-class aerial photography with a thorough study of the resulting photographs by experts in many different fields working in close collaboration. The experience which has been gained is capable of direct application to peace-time research. Indeed, much information of interest in this connection is probably potentially available in the many thousands of negatives already made by the Allied air forces, and it is to be hoped that this will eventually become accessible through appropriate centralised libraries.

Interpretation

There are two main types of aerial photograph—the oblique, that is, the pictorial or bird's-eye view made through the side of the aircraft, and the vertical taken through the floor producing a photograph of the ground as on a plan.

Although to the untrained observer the oblique presents the more familiar view, the scale varies from foreground to background and there is much "dead" ground in hilly or wooded regions, and vertical photographs were of much greater use to our interpreters.

Such photographs are not pictures in the conventional sense, but rather a mosaic collection of details whose meaning is not immediately obvious. The amount of information which an interpreter can extract is directly proportional to his experience. This in turn is dependent on his full understanding of air photographs as a source of information, his knowledge of the subject being studied and his access to a series of photographs of the same area made on earlier occasions. He is immeasurably helped by the fact that the photographs can be viewed stereoscopically; that is, the picture appears to be a visual model in three dimensions. A right and left eye record is necessary for a scene to appear in relief, and the amount of this relief is determined by the distance apart of the two viewpoints. When we examine a scene with our eyes, which are only about a couple of inches apart, all sensation of relief disappears when objects are more than 500 feet away. But the interpreter examines the landscape as though he were a giant with eyes several hundred yards apart, merely by placing in his stereoscope a pair of prints from the series of overlapping records which the detached eye of the flying camera has provided.

Every stereo pair of war-time reconnaissance photographs was studied by specialists in many different fields supplying its quota of information to each. By 1943, we had compiled what was virtually a photographic Lloyd's Register of enemy shipping, and we had learned to tell the type of cargoes and probable destination of every enemy ship that mattered. We followed every important aspect of German industrial activity and knew with remarkable accuracy the month-by-month output of all important factories. We watched Germany's progress in research on radar and atomic bombs. Photographic intelligence revealed enough information about the development of the flying bomb in time for us to make such preparations as were possible to reduce the attacks from a major disaster to a nuisance of no effect on the outcome of the war. Meanwhile, we were accumulating, *via* the air camera, essential information on every aspect of the Normandy beaches and landscape which would facilitate invasion.

Future Applications

We have accumulated, then, considerable experience with a powerful tool of research, and it remains for us to adapt it to the sane requirements of peace. A complete understanding of the various ways in which this is being done would require on your part knowledge of the technique of photography which I must not assume. Accordingly, I shall have to ask you to accept some of my statements as to what is possible on trust, though I will illustrate them as well as I can by photographs showing the techniques in action. The fact that with one blink of its glass eye an air camera can make a detailed record of the countryside which it would take an artist months to draw is of course well known. What is not so obvious is the enormous importance of the fact that the record is an exact one from which sizes and distances can be accurately deduced. Much of the value of air photography in war and peace is due to the many ways in which such measurements can be turned to advantage. The most familiar, because the most obvious, is the use of air photographs in survey.

Surveying

The speed and convenience of aerial mapping has long been admitted, and for inaccessible or difficult country such as the jungles and swamps of Africa, aerial mapping is obviously invaluable, but its pre-war accuracy left something to be desired. As a result of war experience, it can safely be claimed that any required degree of accuracy is now attainable. In some cases, this accuracy exceeds that of conventional ground surveying, while the improved techniques available are resulting in appreciable saving in cost.

The usual procedure is for the aircraft to fly backwards and forwards over the territory to be mapped, taking vertical photographs on calibrated cameras—the dials of instruments recording height, tilt, etc., being photographed simultaneously along one edge of the film. The cameras employed are set to take photographs automatically at predetermined intervals, which are such that there is an overlap of about 60 per cent. between neighbouring records. This is necessary in order to provide the stereo records on which most mapping systems depend. Moreover, to ensure that gaps are not left in the record as a result of navigational errors, the parallel lines of flight are close enough together to ensure a generous overlap between each string of records. This lateral "insurance" overlap, which is wasteful in time and material, is not necessary in the most modern air survey technique in which the navigation of the aircraft and the operation of the survey cameras is by radar control from a ground station. The pilot's responsibility is reduced to keeping his aircraft flying at the specified height along the radar beam, the camera operating at the correct intervals without his intervention. This technique also makes it possible for the ground station to direct the aircraft to any predetermined point on the terrain and then operate the camera as many times as are necessary to fill in any gap in the records of an earlier flight, due, for example, to the presence of an isolated cloud below the aircraft. As a result, two or three photographs are all that are necessary to cover such gaps as against the many hundreds of exposures which are required to ensure proper coverage when navigation and photography are controlled by the aircraft crew.

The resulting photographs are built up into a mosaic record of the whole territory

—a pictorial map adequate for many purposes and containing information from which dimensionally accurate maps can be prepared. The aerial camera in effect brings the territory to be mapped to the surveyor's laboratory for measurement.

It follows from the fact that by suitable techniques a contoured map of the countryside can be prepared that dimensioned plans of buildings can be derived from such photographs. From such plans accurately scaled models can be prepared and rendered remarkably lifelike by sensitising their surface with photographic emulsion and then projection printing on to them from a negative of the target. The clockwork precision of the successful attack on St. Nazaire in March, 1942, owed

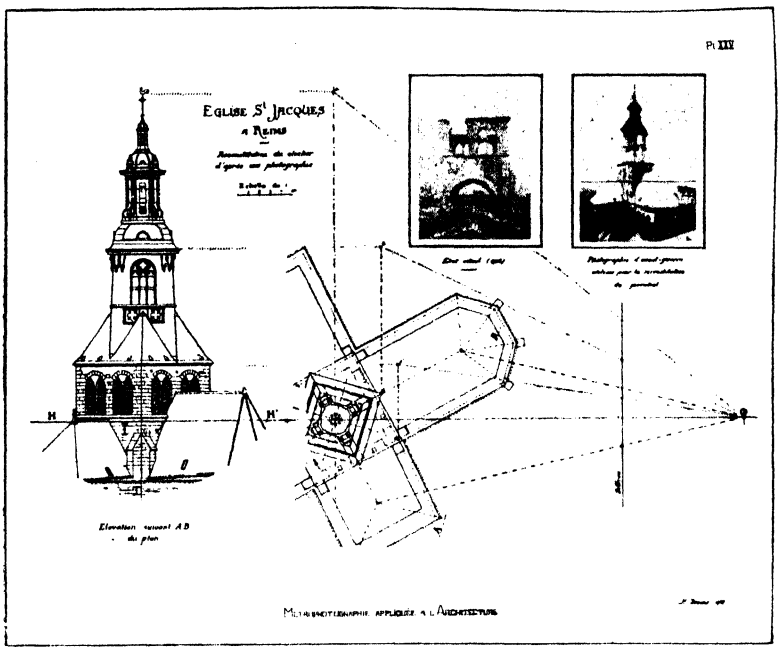


FIG. 1.—*Production of dimensional plans from photographs*
After the church had been destroyed (left) the essential dimensions were deduced from the pre-war snapshot (right)
(Reproduced from "La Metrophotographie Appliquée à l'Architecture," by courtesy of M. H. Deneux)

much to the photographically-produced model of the port which was made during the previous year. This model was photographed from various angles of approach and in lighting corresponding to that which would prevail at the time of the attack. Thus the participating forces were briefed with photographs of their various objectives which looked as though they had been made at ground level from a distance of a few hundred feet.

The technique of deducing the dimensions of a building from photographs was applied after the 1914-18 war to the problem of reconstructing war-damaged buildings of which dimensioned plans did not exist. Several French churches, for example, were rebuilt from accurately scaled plans deduced from snapshots. Fig. 1 is an illustration from Deneux's *La Metrophotographie Appliquée à*

l'Architecture, a fascinating account of the geometrical methods available for carrying out the calculations.

In America at the moment air photographic surveys are being carried out over all existing and several projected highways. It has been shown that it is possible to calculate from the photographs the cubic footage of earth to be removed or the concrete required at particular parts of the route far more simply and accurately than by ground methods, and the economy which has resulted is already regarded as having paid for the cost of the survey.

Air photographs made primarily for survey purposes will record a mass of data of interest to all those concerned with such economic aspects as land utilisation, agriculture, mining, town planning, electricity, water and transport services. In many cases, however, special flights at particular seasons and times of the day will be necessary if air photography is to contribute fully to developments in other fields of which the following are representative examples.

Archæology.—Archæologists were made aware through the pioneer work of Crawford, Kieller and Insall of the value of the point of view given by the aeroplane, and many sites of archæological importance have been discovered by its use. Slight banks, grass-covered foundations or depressions in the earth's surface which are all that remain of early earthworks, may pass unnoticed on the ground, but acquire significance when viewed from such a distance that any shadow cast forms a geometrical pattern which was obviously man-made. Such shadow sites will be most clearly revealed when the sun is low and in the right direction to cast a significant shadow. However, the most fascinating—because quite unsuspected—phenomena which air photography revealed was that growing vegetation is affected as regards its average size and colour by the previous history of the soil. For example, if a ditch has been dug on a chalk down and afterwards ploughed flat and sown with corn, for ever afterwards the silt filling that ditch differs from the ancient, never disturbed soil. The more moist or more fertile silt promotes the growth and deepens the colour of the crop and hence in the spring the ancient excavation is annually outlined by a patch of darker green corn.

Ancient roadways and wall foundations are sometimes revealed by the reverse effect. The shallow stony soil of the site results in a relatively poorer growth of the crop or during a drought leads to more rapid "parching" of vegetation on the site.

A remarkable example is the ground plan of Caistor, near Norwich (Venta Icenovum). The roads, streets, houses, temples and market places of this Roman town are all clearly revealed in an air photograph made during the drought of 1928. It will be a matter of chance whether such crop markings will record on air photographs made for other purposes, and for maximum results specially arranged flights under the direction of an archæologist must be made over areas known to be of interest at appropriate seasons and times. A recent series of flights planned in this way, in two days' flying time, added more to our knowledge of Roman Britain than the previous two centuries of archæological research!

Ecology.—Ecologists, concerned as they are with what might be termed biological geography, have already used air photographic surveys of South America to provide data on the density and distribution of population, distribution of arable land natural barriers and natural avenues of travel, sources of power, fuel and water, land utilisation, facilities for transport and the influence of topography on the location of

roads and towns. Such investigations have a close relationship to the sort of studies we have made of Germany during the war, while the methods so successfully applied to ferreting out the activities of our human enemies are directly applicable to non-human pests—animal and vegetable. The control of such disease-carrying insects as the mosquito and the tsetse fly by spraying from the air is now familiar. More indirect methods of control may well emerge from studies of bird migration and population on inaccessible islands made by means of the air camera. As a minimum, surveys of this type should be a very convenient method of checking the efficiency of our attacks on such pests as the boll weevil or the Colorado beetle. Meanwhile, the advance of bracken over grassland, prickly pear in Australia and the distribution and effect on each other of plant communities (woodlands, jungles, prairies) are already being effectively studied by air photography.

Colour Filter Techniques

So far I have been talking about ordinary black and white photographs of the type one can make with the photographic films used for amateur snapshots, but made through a medium yellow filter. This absorbs ultra-violet radiation and deep blue light which, being scattered by haze, would otherwise reduce the clarity of long-distance photographs. Full advantage has yet to be taken of the fact that, by the use of specially sensitised films and suitable colour filters, the camera record can be made to emphasise detail and differentiate between various features of the landscape in a manner quite impossible to the human eye. Forestry provides a number of simple illustrations. Thus, a recent air survey of the forests of Southern Sweden was made at a season when the beech foliage contrasted with that of other trees—enabling the beech wood resources to be assessed. This is a simple case, however, for, to the eye and the ordinary photographic film, beech foliage is noticeably lighter than the general run of leaves.

By employing over the camera lens a filter which transmits only the particular part of the spectrum reflected most freely by the foliage being studied, it is possible to exaggerate in the photograph subtle colour differences which would be undetectable on an ordinary photograph.

An extreme example of this technique is the use of films made sensitive to invisible infra-red radiation. Infra-red photographs differentiate coniferous trees very strongly from deciduous—the latter recording as though their foliage was white.

An interesting war-time application of such colour filter techniques was the determination of the depths of off-shore water along enemy coast lines. *If a beach is photographed vertically from the air a fair amount of underwater detail is recorded. This means that we are photographing the sea bed through the overlying water. Now red light is more rapidly absorbed than green light during passage through greenish sea water. If therefore we take two photographs—one through a green filter and one through a red filter—the relative blackening on the two photographs which is determined by the amount of light reaching the film will be greater in the case of the green filter photograph and the magnitude of the difference will depend on the thickness of the overlying water. By careful measurement of these relative blacknesses it is therefore possible to calculate the actual depth of the water down

*Devised by the Army Air Photography Research Branch at Larkhill,

to depths of 40 feet. Such information was invaluable in planning landings on enemy coasts and has already found one peace-time application in oceanography.

Marine biologists are using it for making surveys of animal communities such as oyster beds and seaweed concentrations. In its present form it has potential value in the preparation of navigation charts, control of pollution, erosion, and the study of the effect of currents and tides on the formation and movements of sand bars. When sufficiently refined, it has been suggested that the method might even be capable of distinguishing between the differing bodies of sea water whose movements determine the movements of fish shoals. The shoals themselves could almost certainly be detected by appropriate forms of reconnaissance photography—an innovation which would have obvious economic importance.

Forestry.—These, however, are possible future applications of colour-filter techniques where the records must be made under properly controlled conditions if they are to prove of real worth, and, as I have already indicated, their present use is mainly in forestry studies. Here, even qualitative techniques have already proved of real value. Thus Canadian foresters, from aerial photographic surveys of forest land, have obtained, in addition to such obvious data as the types and density of trees, details of the composition, age and structure, which are invaluable in forest control. From the photographs, type maps can be prepared which speed up, simplify and cheapen the operations of forest management. By measurements on stereoscopic pairs of photographs the height of the timber can be determined by simple instruments. Air photographs are also used in fire control planning, evaluation of damage by insects, location of property lines, relocation of Canadian highways and the planning of new ones.

It is frequently suggested that colour photography from the air would simplify the task of interpreting such photographs, and already it is known that in some cases useful information not obtainable from black and white photographs can be recorded on colour film. Insufficient experiments have so far been made, however, to draw any but the most general conclusions.

An aerial colour photograph is easier to interpret by the unskilled, but it is possible that, only in certain special cases will it be of important assistance to the skilled interpreter.

During the war a limited amount of "Aero Reversal Kodacolor" was used by the British and American Air Forces. This was an integral tripack film which yielded subtractive colour transparencies built up from inseparable yellow, magenta and blue-green dye images. Its main application was for such specialised purposes as recording the coloured identification pattern of the target indicator flares dropped by the Pathfinders during night raids and the recording of underwater obstacles near landing beaches in the Pacific.

In a modified form of this film one of the sensitive layers consisted of an infra-red emulsion and the three layers were processed in colours which were not necessarily complementary to their colour sensitivity—as is required for a "natural" colour rendering. In consequence, green grass, for example, might appear magenta in the colour transparency and features in the landscape which in a normal colour photograph might escape detection could often be clearly differentiated in this "camouflage detection" film. Such material has potential peace-time applications in

forestry, but more objective research is required to evaluate statistically the relative advantages of such specialised forms and natural colour as against black and white air photography, for it is easier than might be thought to be the case for a skilled interpreter to distinguish between different types of vegetation in black and white aii photographs.

Geology.—In some regions, vegetation is zoned with respect to elevation, inclination of slopes, proximity of water and rock outcrops, and hence provides a guide to the interpretation of topographic features, some of which—such as the site of old beaches—are obscure on the ground.

Changes in vegetation over a period of time are often associated with important topographic processes, and as the surveys spread to such vegetation types as sphagnum bog and submerged seaweed beds, they impinge on the interests of geologists, for they yield indirect data on such problems as the silting of estuaries, coast erosion and other factors controlling the development of scenery.

The geologist is, in any event, already aware of the value of air photography in simplifying his studies of geological structure and land forms. Thus, the size, shape, distribution and evolution of complex sand dunes is much easier to assess from the air. Air photographs made for such purposes will in turn facilitate the work of prospectors for mineral deposits, and the mining engineer. In Canada, for example, the information on the distribution of rock formations furnished by the early geologists was mostly confined to the main water routes and did not help in the case of wide areas distant from the principal rivers. It is estimated that only 11 per cent. of Canada has so far been adequately mapped from this point of view, and that without the use of air photography it would take 200 years to complete the task at the present rate of progress. However, the Canadians are now going all out on an air survey programme, and during 1946 a basic photographic coverage of about half a million square miles was obtained—about one-seventh of the total area. For 1947 the target is another three-quarters of a million square miles. Already this work has paid a dividend in the discovery from the photographs of rich tantalite deposits.

Soil erosion.—One of the earliest and most characteristic features of the growth of a civilisation is the change which is imposed on the vegetation of the countryside. Where Nature would have a forest—or, as in the case of the Nile Valley, a desert—man makes fields, and so on. When, as in England, the country is small and the civilisation old, one finds that the landscape is eventually almost entirely man-made. With increasing facilities for making such modifications which the twentieth century has placed in his hands man runs grave risks of upsetting the balance of Nature to his own detriment—as when he creates huge deserts in America by unwise deforestation. The new deserts in turn facilitate the production of disastrous floods which, among other things, may lead to the transfer of alluvial soil to inconvenient regions.

Accordingly, extensive development of land by empirical methods will sooner or later have to give way to controlled development based on a study of conditions which can conveniently be made from the air. Since the natural vegetation over any particular region is a product of the various geological and climatic attributes of that region, its study before any development is planned can lead to a rational

exploitation of virgin land and appropriate modifications to our treatment of land which is being misused.

Already over 50 per cent. of the U.S.A. has been photographed from the air to enable the Soil Conservation Service of Washington, D.C., to compile an inventory of the physical land factors involved in soil erosion. These photographs are used to determine soil type, land slope, gradient, present use and degree of erosion. The records not only provide a factual bird's-eye view of the land and its present condition, but will be invaluable in future years as a basis for comparing land conditions from time to time and for following trends in land use. The acreage of crops and other vegetation can be determined very rapidly and economically by colouring the photographic prints according to the crop, cutting up the prints and weighing the collection of various shaped pieces of any one colour. The area can be determined from this weight with an accuracy of 1 in 1,000. Such photographs can also supply a basis for the making of payments to farmers for diverting acreages from soil-depleting to soil-conserving crops, and for carrying out approved soil building practices.

Physics

The photographs we have been considering were all made from aircraft flying at heights of not more than a mile or so and the physicist is, on the whole, only mildly interested in them for the data they provide on atmospheric haze. The physicist is more interested in the records obtained on photographic plates which have recently been sent into the stratosphere in rockets. He has thus obtained records of cosmic radiation and the sun's spectrum made above the absorbing blanket of the atmosphere. The man in the street is more impressed when automatic cameras installed in such rockets primarily for other purposes bring back from 100 miles up photographs of the earth's surface which demonstrate conclusively that the earth is a ball. However, the data on cosmic radiation will, in the long run, be a far more important contribution to our control over Nature than spectacular confirmations of something known to Galileo.

Conclusion

Unfortunately, many of the most interesting peace-time applications of air photography have no immediate commercial future, and the problem is therefore how to get such work carried out. The British Ecological Society has taken a first step by circulating to scientific authorities and responsible Government departments a memorandum recommending the establishment of an aerial unit for scientific work. Such a unit would form an invaluable focal point for researches in many fields and would be of great potential value in another connection. Photographically speaking, we were very backward in air photographic techniques at the beginning of this war. Photography was not highly regarded as a service career and certainly offered few attractions to the scientifically trained young minds on which research largely depends. The question is therefore how to keep alive this interest in the minds of intelligent men, who doubt whether the next war will be anything like the last one and who are averse to wasting their creative energy on the devising of techniques which may not be required. The creation of aerial units for scientific work operating

from the principal armed forces' air photographic research establishments would seem a reasonable solution, if any group of investigators faced with a scientific problem which air photographs might help to solve could, through appropriate mechanisms, have access to such units. The ground technicians would then have a worthwhile interest in devising modified equipment and techniques for the solution of many different types of problem.

There would be real satisfaction in being a member of a team whose work involved helping, through an archæological group, to uncover details of our history; helping, under the guidance of physicists, to clear up the mystery of cosmic radiation; fighting with the geologists against soil erosion and with the ecologists against the ravages of pests; and so on. Devising techniques most suitable for each type of investigation would result in the accumulation of experience and a nucleus of the right type of trained research worker and technician. It would follow that, if there is another war, photography from the air will be ready from the word "go" to play its part in man's next effort at destroying what is left of his civilisation.

LECTURE II.—*Delivered May 12th*, 1947

SOME APPLICATIONS OF PHOTOGRAPHY IN INDUSTRY

When, in 1839, Arago announced the daguerrotype process, he foreshadowed the many ways in which photography would contribute to the development of science and industry. At that time a camera was little more than a light-tight box with a piece of sensitive material at one end and a means for forming an image—usually a simple lens—at the other.

To-day there exists a bewildering variety of instruments all legitimately described as cameras, but varying in weight from a few ounces to many tons, and these employ as many as 400 different types of photo-sensitive material to record the images they produce. Accordingly, any lecture attempting to cover the scope of modern applications of photography tends to become an indigestible collection of disconnected titbits.

In the first lecture the issue was avoided by concentrating on a single branch of photography, but even so I am aware that the subject was scamped. This afternoon I am taking refuge behind the qualifying "Some" of the title and shall concentrate primarily on those applications whose contribution to industrial efficiency has been notably increased by war-time developments.

Broadly speaking, photography is of value in commerce and industry because it can:

(1) make records which are permanent sources of reference and exact measurement in a variety of convenient forms,
(2) operate efficiently under conditions where the eye is helpless either because the light available is too high or too low in intensity, because the event is too transient or too protracted to see or because visible light is not involved at all,
(3) record movement, if necessary in such a way that the time scale is altered.
(4) play a basic part in certain fabrication processes.
(5) facilitate all aspects of training and education.

RECORDS

Let us dismiss with a mention such obvious applications as the choosing of factory sites by aerial survey, the recording of each stage in the erection of buildings and plant and the photographic printing processes—known as blue print and diazotype—by which the plans for such activities are duplicated. A conventional photo-copy of a plan made by these processes is the same size as the original and only minor improvements in the processes themselves have taken place in the last 20 years. Document copying processes in which enlargements or reductions are possible, however, are growing rapidly in importance. In these processes the original is photographed by various forms of specialised camera on to bromide paper, photographic film or plates. In the mere fact that the photographic record can be made smaller than the original we have the subject-matter for a long book, for new applications arise almost daily.

In the Statfile system, engineers' drawings are reduced to $6\frac{1}{2}$ inch by $4\frac{3}{4}$ inch records on non-inflammable film. In this form an enormous bulk of drawings can be filed in a relatively small space and at a standard size. From the negative, copies on paper to any required dimensions can be produced by conventional enlargement. In addition, there are numerous systems for recording documents on 35 mm. or 16 mm. film with correspondingly greater saving of space. These range from primitive adaptations of conventional miniature camera equipment to specially designed fully automatic machines which can be operated by people with no knowledge of photographic technique.

During the war essential information about every member of the armed forces was recorded on 35 mm. film, in the first instance to simplify keeping pay records, etc., up to date. However, the same technique obviously facilitated the sending of information on other subjects from one theatre of war to another. A specialised aspect of this so-called microgram service, namely, the Airgraph scheme—a direct descendant of Dagron's pigeon post from beleaguered Paris—made one advantage of such micro-records obvious to the general public, who received and sent more than 1,000 million Airgraph and V-mail letters during the war. The original letters were photographed on to 16 mm. film for convenience of overseas transport and bromide print enlargements made at the receiving end for dispatch by surface mail.

The release and saving of valuable storage space, protecting of irreplaceable records against loss by war, accident or theft, and the increased availability are obvious advantages of micro-records, of which banks and big business houses are making growing use. U.S. public documents can now by law be thrown away if miniature film copies exist. One machine tool firm which had nearly half a million drawings occupying 1,500 square feet of floor space has now microfiled the lot in two drawers of a letter file. Libraries, which began by storing the contents of newspapers in this way, are now extending the method to their books. All English books in the British Museum written before A.D. 1500 have been recorded in this way, and the Library of Congress offers a service of microfilms or positive enlargements of any part of its ten million volumes. Such reproductions serve the student just as well as the, often irreplaceable, originals. This technique has also been suggested as a means of dealing with the problem of publishing and distributing

those scientific papers which are too specialised or transient in interest to justify printing in full in the ordinary scientific journals.

Specialised machines—of which the Recordak is a typical example—have mechanised the procedure for transforming huge piles of documents into midget records on microfilm to a point where the equipment can take its place side by side with other "business efficiency" aids such as accounting machines and office duplicators. In the latest model of the Recordak, for example, documents such as cheques need only to be fed into a slot by the operator. When they emerge a few seconds later both sides of the document have been recorded next to each other on 16 mm. film. Many documents are recorded in this way, at a rate of 1,000 per hour, if necessary, purely as a safeguard against loss or fraud—for example, the cheques passing through a banker's clearing house or the incoming entries complete with serial number and date in football pool and bookmakers' offices. In such cases systems are available for finding automatically particular records on the negatives. For smaller users combination units are available which both make the microfilm record and project it for reading purposes.

Increasing attention is also being given to mechanising the production of paper prints from these negatives, and war-time developments in high-speed automatic processing are a promising first step in this direction. Thus the U.S. Navy required positive photographic records of the images produced on the fluorescent screen of radar cathode ray tubes in the shortest possible time. The problem was solved by producing a photographic film which could be processed to a positive image in a matter of seconds in a processing machine which applied hot solutions to the film in rapid succession. Each solution was removed in turn by vacuum suction and permanent records of the changing images on the radarscope could be seen twelve seconds after photography.

In America hot processed motion pictures have already been used experimentally as a source of television "originals" of news events. The overall time for complete processing and drying a single frame of the 16 mm. used was 45 seconds as against 40 minutes for the normal procedure, and the processing machine operated at the rate of 8 feet per minute.

The R.A.F. asked for a photographic paper which could be printed in contact with an unwashed negative and dried in a minimum of time, and here again the problem was successfully solved.

By combining these two techniques, suitably designed machines would make it possible to produce a large number of copies of a document in a matter of seconds if this was required.* A fully automatic machine of this type would, of course, be an expensive piece of equipment, and small organisations are more likely to be interested in the various improved forms of reflex copying systems. In making a reflex copy of a document a sheet of thin photographic paper is pressed into contact with the document to be copied and this is then exposed to light through the back of the sensitized paper. The difference in the amount of light reflected by the dark and light portions of the original document is utilised to form the photographic image. Upon development, a negative image is obtained from which any number of positive prints can be made.

* At this point the lecturer was photographed and a print produced in a matter of seconds.

Crude reflex copies can be made with ordinary photographic paper of high contrast. For best results special forms of so-called reflex bromide paper and specially designed printing frames are recommended as a simple method of obtaining copies of documents at a cost of a few pence per square foot and minimum capital outlay.

Quality of Raw Materials

Turning from business to industrial efficiency, let us glance first of all at photographic tools which are helping to control the quality of raw materials. Most of these tools originated in research laboratories, because scientific research is based on efforts to reduce phenomena to forms that can be seen and measured. The powers of exact description provided by photography are the very foundation of precise knowledge and make it natural to use appropriate types of photographic material as the retina of microscopes, telescopes, spectroscopes, oscilloscopes, stroboscopes, stereoscopes and X-ray tubes converting them into recording instruments infinitely more versatile than the human eye.

Using these instruments enables us to reveal and record layer by layer the composition, structure and characteristics of materials. Starting at the outside, a beam of electrons, if suitably reflected from the surface on to a photographic plate, produces a diffraction pattern which reveals the arrangement of the atoms in the outermost layer of the reflecting body—of importance in the study of lubrication, polishing processes and other surface phenomena.

Photomicrography normally records the surface as the eye sees it. By sending a beam of electrons through thin layers of material an electron image of objects far smaller than can be seen by optical instruments can be recorded photographically. X-rays, when suitably reflected from surfaces, form diffraction patterns on photographic plates which will reveal the architecture of the molecular structure of matter to a depth of a few hundred atoms. X-ray micrography, in which X-rays transmitted by layers a few fractions of a millimetre thick, are recorded on fine-grain photographic emulsions, yields radiographs which when studied under the microscope will settle such questions as whether the copper in a copper-aluminium alloy is in solid solution or not. Infra-red photography will penetrate thin crusts of rust and reveal, for example, the cause of porosity in tin-plating.

The now familiar radiographic and gamma ray techniques enable flaws and faults to be recorded even though they are embedded in the centre of steel a foot thick. Finally, the Betatron, which generates 20 million volt X-rays, is extending this non-destructive probing for faults into even greater thicknesses of metal.

Some of these techniques are still in the laboratory stage. Others have already been harnessed as industrial tools as a result of the development of apparatus which can safely be placed in the hands of people almost completely ignorant of physics. Of these techniques, let me illustrate three.

Spectrographic Analysis.—The conventional method of determining the composition of materials is by chemical analysis, and this is still the most reliable method in the case of non-metals. The engineer's main raw materials are, however, metals, and in particular alloys, and here photography in conjunction with the

spectroscope has freed hundreds of people from the boredom of routine analyses, for it yields in a few minutes and at a fraction of the cost, results which would otherwise involve hours of laborious work. Spectrographic analysis as a technique was handed over to industry almost ready-made by astronomers who had perfected it in their efforts to determine the composition of the stars. Industrial spectrographic analysis is based on the fact that when elements are heated in, for example, an electric arc, they emit characteristic line spectra. In a mixture of substances the intensities of the lines of the various elements, as recorded on the photographic plate of the spectrograph, are related to each other in a way which depends on the percentage present.

Both qualitative and quantitative analysis of a minute particle of a substance is therefore possible in the few minutes necessary to expose and process a photographic plate and measure the densities obtained with a micro-densitometer.

Absolute methods of quantitative analysis in which the densities of the lines are interpreted directly as percentages are not yet reliable for a variety of reasons. On the other hand, the majority of routine works analysis is performed to keep a check on the uniformity of a product. Accordingly, specimens of accurately known and qualitatively similar composition are used as standards for the production of graphs from which the analysis is read off direct, the spectrum of these comparison standards being recorded for reference alongside that of the sample to be analysed. In this way very high accuracy can be achieved by a purely routine procedure. It so happens that the "sensitive lines" of metals (*i.e.*, those which are in evidence when only minute quantities are present) lie between 2,000 and 10,000 A., and are therefore accessible with a quartz spectrograph working in air and recordable only by photography. The sensitive lines of most non-metals are of wavelengths shorter than 1,850 A., and here a vacuum spectrograph—a more expensive instrument—is required. Accordingly, although the economy in time and material with which spectrographic analysis can be carried out suggests that it may eventually replace the majority of routine chemical analytical control, as yet its chief industrial application has been metallurgy. The application of the method to the control of the composition of alloys has been one of the outstanding developments in the non-ferrous metal industry during the past ten years. Refining operations can be followed step by step, and many firms now control their foundry output by this method. In the case of alloys, the reference standards referred to above must have a known history, since the intensity of the lines in an alloy spectrum may vary according to whether the samples are in the as-cast state, the wrought state or in the heat-treated condition.

The working procedure has been reduced to a simple routine by the design of apparatus requiring a minimum of adjustments in use and specially devised photographic plates whose characteristics facilitate the easy interpretation of the records.

Metallography.—From the engineer's point of view the correct chemical composition of a structural material is, however, only half the battle. It may still be useless for his purpose if the constituents are not properly combined or the material is non-homogeneous. Unless, therefore, the engineer knows his material literally *inside* and out he must play for safety in designing castings, struts, and so on,



FIG. 2.—*Typical air-survey photograph made with the R.A.F. Radar-controlled F 66 Air Survey Camera from a height of 30,000 ft. Note the instrument readings recorded at time of exposure. The territory covered by this exposure is 80 square miles.*

(Crown copyright reserved)



FIG. 3.—*Plan of Roman Villa, Ditchley, Oxon. No sign of the villa or its surrounding walls can be seen in Autumn when the land is ploughed. Every spring the plan is outlined in growing crops, which locally are greener and stronger wherever the earth was disturbed nearly 2,000 years ago.*

(Reproduced by courtesy of the Ashmolean Museum)

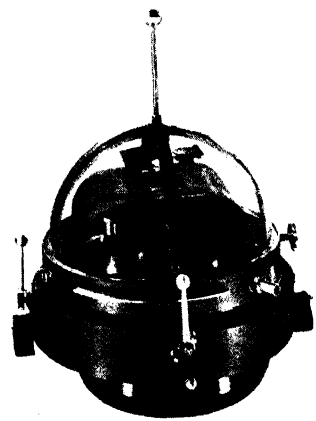


FIG. 4.—*A modern air survey camera in its plastic temperature-controlled jacket. (The Williamson O.S.C. Mk. I.)*

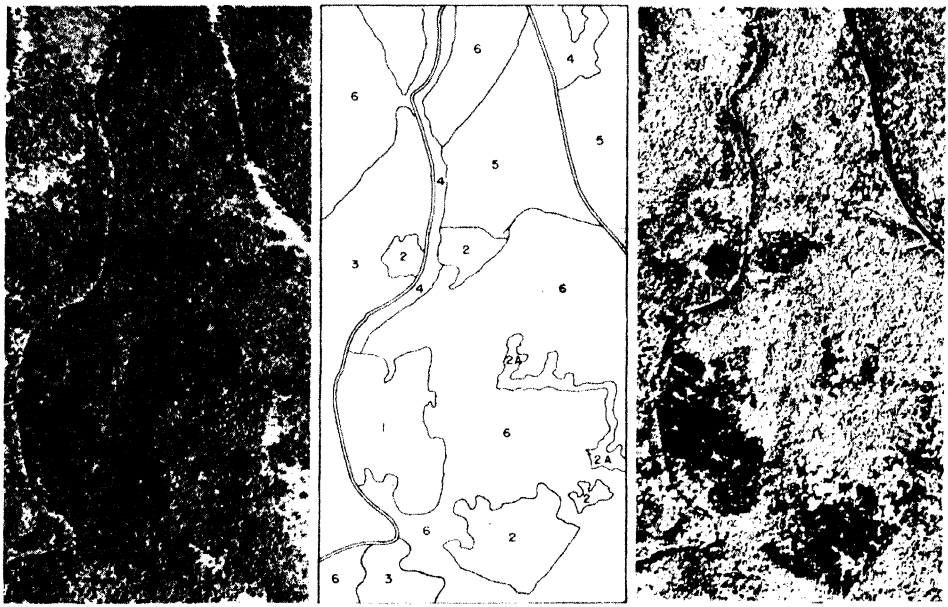
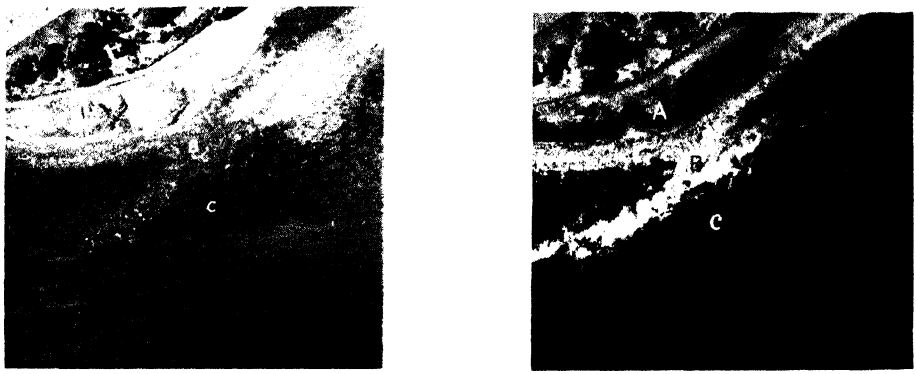


FIG. 5.—*Forestry.—A comparative Infra-Red and Super XX Panchromatic photograph of the same area of forest. This technique enables certain types of conifer to be differentiated. The subtle differences are lost in half-tone reproduction, but from the actual photographs the six types of tree are distinguishable as follows :*

1. *White pine—old growth.*
2. *White pine—young growth.*
2A. *White pine indicating old fence row.*
3. *Mixed white pine, hemlock and hardwoods.*
4. *Hemlock.*
5. *Mixed hemlocks and hardwoods.*
6. *Hardwoods.*

(Reproduced by courtesy of Harvard Forest and Fairchild Aerial Surveys, Inc.)



(i) *Green filter photograph* (ii) *Infra-red photograph*

FIG. 6.—*Detection of commercially valuable seaweed by comparing photographs made by green light and infra-red radiation. Print* (i) *shows a belt of probable rock weed* (B) *and a belt of bottom weed* (C). *That belt* (B) *is weed and not dark-toned or wet bare rock is clear from print* (ii), *on which the weed appears very bright owing to its high reflectivity in deep red light. Bare rock* (A), *or sand and shingle appear dark on print* (ii) *in contrast to the weed, underwater weed* (C) *is invisible on print* (ii) *except for isolated plants covered by only a few inches of water ; stereoscopic examination of green prints confirms bottom weed here.*

(Reproduced by courtesy of Majors P. K. Wiggs and P. E. Conant, and the Army Photographic Research Unit)

compensating for ignorance in this respect by undesirable dead weight. This is costly, and, in such machines as the modern aeroplane, impracticable.

Fortunately, in the case of metal and alloys a thorough examination of the surface layers of properly chosen specimens will provide much valuable information about the metallurgical structure of the material.

The photographic examination of the surface of metals is called metallography. Such mechanical properties as hardness and ductility are related to the microstructure of metals and alloys, and numerous defects are directly attributable to abnormalities in this structure, which is built up of a mass of interlocking crystals. Accordingly, one of the main objectives of the metallographer is to obtain photomicrographs of polished and etched metal surfaces recording the nature and size of the individual crystals. Recording their change in size and nature with heat treatment cold working and fatigue has helped to explain the basis of these phenomena and—more important—helped to bring them under the metallurgist's control.

Photography of the macrostructure, *i.e.*, the structure as seen by the eye, not only helps in the selection of significant areas for photomicrography, but provides a record of markings indicative of unsoundness, cracking, segregation, and other faults.

The distribution of particles of sulphide in steel provides a clue to the process of crystallisation and can be recorded on the photographic emulsion without the use of a camera, simply by placing a sheet of bromide paper soaked in dilute sulphuric acid in contact with the polished surface of the specimen. Hydrogen sulphide is liberated locally by reaction between the sulphides and acid, and this in turn reacts with the silver halide in the photographic paper, forming a dark silver sulphide image.

X-ray Crystallography.—X-ray crystallography is another typical example of the development of a research into a works tool. This is a technique which reveals the molecular architecture of crystals by a study of the patterns produced when narrow wavebands of X-rays are diffracted during their passage through the material. The atoms of solid substances are always arranged in a characteristic manner which determine the physical properties of the material in bulk. The various patterns produced by diffraction by parallel layers of atoms are characteristic of these various geometrical groupings. The first interpretation of these spectra requires of course an expert physicist, but from the point of view of non-destructive testing the method can be used in a variety of ways by workers who need no more knowledge of the physics of the subject than the average owner of a wireless set has of the physics of radio. The interpretation of patterns produced by a modern industrial X-ray crystallographic unit is in their hands not so much in terms of crystalline structure as on such broad but informative lines as variations in heat treatment, corrosion, cold rolling, annealing and residual stresses. It is interesting to note that a "picture" of a molecule showing the arrangement of the atoms in space can be made by working back from this diffraction data. A series of masks is made consisting of opaque bands whose widths and orientations are calculated from the diffraction records. Successive exposures on a single sheet of photographic paper are made through these masks and the superimposed record shows the spacial arrangement of the atoms in the molecule. This method

eliminates the laborious calculations inherent in indirect methods of determining molecular structure from X-ray diffraction data and the physicist's picture of a molecule which results is identical with that previously deduced from chemical evidence.

Fabrication Processes

Turning now to fabrication processes, perhaps the most potentially valuable development will be the wider application of a photographic technique which shortened by months the period between the design stage and the first flight of the later types of aircraft. This is the so-called photo-template system. A template is a copy or pattern of some part of a mechanical structure. It is usually flat, made of

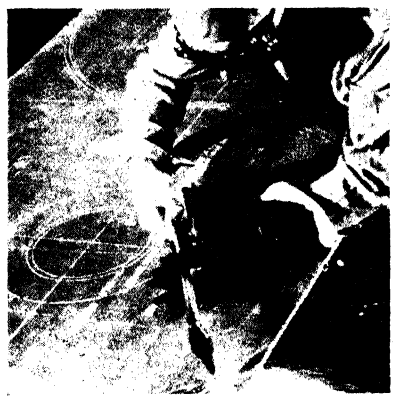


Fig. 7.—*Cutting out parts to a design photographically reproduced on metal sheets*

metal or wood and carries construction details of the particular part which assist the fabrication and assembly of machinery or equipment.

Templates have been used since the beginning of the nineteenth century and some of the more elaborate modern forms require as many as 400 man-hours to draw out. Moreover, the laborious scribing operations involved have often to be carried out as many as half a dozen times. It has frequently been pointed out that a tremendous amount of time could be saved and risk of dimensional errors eliminated if these subsequent drawings were reproduced on the metal by photography. It was, however, the special combination of circumstances arising in mass production of war-planes that brought about practical development of this idea. A modern aircraft contains as many as 25,000 parts, whose outline at some stage had to be drawn on metal with an accuracy measured in thousandths of an inch. The design serves as a guide when the sheet is cut, filed, drilled or punched to make the aircraft part itself or the tools with which such parts are made. For the precision inspection and assembly of components, accurately made check template and assembly jigs are required, all produced from the same basic drawings. The high degree of precision essential, the complexity of the designs, the frequent modifications as design progressed, the need to ensure exact interchangeability of parts

made in different aircraft plants and the vital need for speed resulted in the photographic reproduction technique becoming thoroughly established in American aircraft plants. Months of time and many thousands of pounds were saved on each design, and it seems certain that such methods will find peace-time applications in other engineering industries.

In a typical photo-template technique the design is scribed once and for all on lacquered aluminium sheets. These are placed on suction copyboards and photographed down on to glass plates, using precision cameras of the process-engraving type. The negatives are then projected in the same apparatus on to sheets of aluminium sensitised with photographic emulsion.

The big advantage of this projection system is that the scale can be altered when required—for example, to allow for different degrees of shrinkage when the metal from which a part is to be made is changed or when preparing small models for wind tunnel or other forms of examination. The projection process is, however, relatively costly to instal, for precision equipment is essential if the photographic image is to reproduce the original within the tolerances of typical specifications.

For small parts where no change in scale is involved a simpler and cheaper method is to make a reflex copy of the full-size drawing on a glass photographic plate and then print the negative down on to a metal sheet coated with a light-sensitive emulsion. Alternatively, the original drawing can be made on a translucent coating on plate glass and contact negatives made from this are then printed directly on to the sensitized metal. However produced, the metal prints are then cut out and become the templates or patterns that go to the shops.

It is claimed that photographic template methods have saved as much as £5,000 in building prototype aircraft and shortened the time between designing and test flight by from two to four months as a result of the reduction of time required to turn out patterns for shop fabrication. So far, only the aircraft industry has made any serious attempt to exploit the process. It would, however, seem immediately adaptable to motor-car and boatbuilding, even if only to facilitate the work involved in making mock-ups, *i.e.*, full-scale models in wood, by photographically reproducing the original layout directly on the wood, which the builder would use immediately without the delay of marking out.

Photo-mechanical Processes.—Photographic prints on metal are the basis of another major industry—photo-lithography—and here again war-time researches have made possible considerable simplifications in the working procedures. Thus the rapid production of maps in the field was facilitated by the preparation of zinc plates coated with photographic emulsion on to which negatives could be projection-printed. A simple processing technique resulted in litho printing plates ready for use. Although this technique simplified printing plate production it did not cheapen it, and further development of this technique may well be of greater interest to business houses who already employ simplified photolitho methods for preparing their own literature rather than to litho printers as such.

The introduction of so-called "coloured contact screens" which eliminate the necessity for skilled hand work in reproducing half-tone illustrations is however an important advance. These screens may well represent the most important improvement in the half-tone process since the introduction of the ruled screen itself. They

enable the contrast of the final printing plate to be adjusted to that of the original as a result of making controlled variations in the colour of the printing light and at the same time they automatically yield a much closer approach to accurate tone production than can be achieved by the conventional half-tone process.

A typical photomechanical printing plate is in effect a photograph in metal, and by making the original drawing a suitable design it became possible to make exceedingly delicate metal devices—such as the grids of valves or the hair-line resistances known as strain gauges—by stripping the metal photograph off its temporary glass support.

Sometimes, as in the thousands of hair-line graticules which were used in gun sights, the metal image is left on its glass support. By using substantially grainless photographic emulsions the lines on such graticules were quite free from graininess and could, when necessary, be made so thin that as many as 1,200 separate lines could be produced in each millimetre width.

Quality of the Product

Radiography.—The war also led to a considerable increase in the use of photographic methods for examining fabricated articles. The most important of these was radiography—the recording of X-ray images on photographic film or paper.

X-ray pictures are essentially shadowgraphs made by placing the object to be examined between the X-ray tube and a fluorescent screen or a light-tight cassette containing photographic film. The image which is seen on the screen or recorded on the film is produced by differential absorption of the radiation during its passage through the specimen and, when articles made of light metal and of low economic value are to be examined as manufacturing routine, visual inspection of the image is the usual practice. Examination of the core of golf balls, flash lamp cells, or of the electrode assembly of small radio valves are typical examples. The method is also useful for the inspection of lower-grade light alloy castings. The photographic method is, however, essential for dense materials, for the examination of fine detail and where records are required to meet a specification. Typical examples are the checking of the proper alignment of the inner components of sparking plugs, shell fuses, torpedoes, electrical condenser units and vacuum pumps. In some cases visual and photographic inspection is profitably combined. Thus the centering of the core of a heavily insulated cable can be viewed at right angles as the cable is drawn behind the fluorescent screen. On seeing a suspected region, the operator throws a switch, thus making a radiograph and marking the region in question on the casing.

During the development stage of an assembly, X-rays will help to demonstrate why a device fails to function, examples being the revealing of the presence of drops of solder which may cause short circuits, or, in the case of a Bourdon gauge, interfere with the hidden moving member.

The value of X-rays as an inspection tool has been clear since Röntgen made the first half-dozen radiographs some 45 years ago, for five of these were typical of the subjects now examined by the industrial radiographer. The early industrial applications of X-rays were, however, attempted with adaptations

of apparatus primarily designed for medical work, and it was only when equipment specially designed for industrial use appeared that radiography came to be regarded as an essential engineering technique.

Typical industrial equipment is mobile and can be applied to structures in situ. It thus becomes possible to determine the position of concealed wiring and plumbing, determine the general character of the reinforcement in old concrete floors to be used for supporting new machinery or check telephone poles in the highways for unsound wood. Repeat radiographs of old timber will show whether death-watch larvæ are alive by recording any change in their position. These are more or less specialised applications, however, and it is in the foundry and welding shop that X-ray equipment has become imperative.

It is now quite common for specifications to demand radiographs of welds and castings, for X-rays will demonstrate the presence of cracks, blow-holes and slag or sand inclusions which might otherwise be revealed only after expensive machining or remain as an undetected menace to the soundness of structures on which our lives may depend. Not only does radiography reduce machining costs by keeping unsound parts from the production line but, by showing the nature and location of irregularities, it indicates methods of avoiding them, thus increasing the yield from such raw materials as castings. Because radiography enables soundness to be assessed it often permits the use of lower cost materials and fabrication methods as when sand castings are substituted for forgings or spot welding for slower rivetting. Accordingly, no high-pressure welded boiler receives a Lloyds' Class I certificate unless radiographs of every weld are forthcoming, and every light alloy casting used in aircraft construction is first submitted to X-ray examination. The thickness of metal which can be penetrated is directly related to the kilovoltage of the X-ray set, and a modern portable industrial unit employing 400 kilovolts will penetrate up to 5 inches of steel. For thicker or inaccessible specimens gamma rays are employed.

Gamma radiography.—Whereas the wavelengths of X-rays are approximately one hundred thousand times smaller than those of visible light, gamma rays are nearly one million times shorter and we have to employ one million volts to generate them by the technique used to produce X-rays.

Radium is a natural source of gamma radiation, and a radium bomb—that is, a tiny fragment of a radium salt enclosed in a platinum capsule in a protective lead cylinder—is all the equipment required. Exposures of the order of several hours are given by removing a lead plug in the cylinder, and radiographs through 8 inches of steel are possible. Radon, which permits an even smaller source of high gamma-ray intensity, is to some extent replacing radium in industrial radiography. It is highly probable that artificial radioactive elements will also be employed for this purpose in the future.

X-ray equipment has been devised which will yield gamma rays. An example is the Betatron, which is essentially a specialised form of transformer in which the secondary consists of electrons rotating in a ring-shaped vacuum tube. At a certain point in the alternating current cycle an additional high voltage pulse is applied to the primary causing the electron orbit to expand. The electrons in consequence strike a platinum target producing million-volt X-rays which will penetrate 20 inches of steel—a thickness far beyond that economically practical by other means.

High-speed radiography.—For the majority of industrial work, an exposure of seconds is of little consequence, but a new type X-ray tube permits radiographs to be made with exposures of 1/500,000th second. The tube is so designed that currents of the order of 2,000 amp. can be passed through it as a result of condenser discharge, and radiography of rapidly-moving enclosed machine parts, such as pistons or the impeller blades of turbines, has become practical.

The silhouette photograph of a golf ball at the moment of impact aroused admiration a few years ago, and we had hardly recovered from the surprise created by Edgerton's substitution of a fully-detailed photograph for this silhouette when with this new technique we obtained a record of how the inner core of a ball behaved at the critical instant.

Let us now turn to techniques of value in assessing the performance of machines and in search into new designs.

High-Speed Photography

One of the earliest triumphs of applied photography was the freezing of the image of events lasting minute fractions of a second, thus permitting their study at leisure. The subject was illuminated by an intense flash of light produced by the discharge of an electrical condenser across a spark gap. Various types of circuit have been devised, some of which yield a flash shorter than one millionth of a second.

In a convenient modern light source the discharge takes place across a gas-filled tube yielding a flash of intensity equal to 50,000 40-watt bulbs with an effective photographic duration of about 1/30,000 second. The tube has a life of well over 5,000 flashes. Typical of the engineering applications of such equipment is the photography of an aeroplane propeller revolving at high speed and determination of the amount of distortion during rotation by making measurements on the photograph.

Flashlight technique of this type permits the use of an ordinary camera. When, however, the subject is luminous, specialised forms of camera are necessary. Thus, in studying the propagation rate of burning explosives, photographic film has been attached to drums driven at right angles to the direction of flame travel and so caused the flame to draw graphs which enable the changing speed of the explosion wave to be measured. Spinning mirrors have been used to move the image of such flames over a stationary photographic plate and so record the life history of explosions lasting minute fractions of a second.

I suppose the most photographed event in history was the atomic bomb explosion at Bikini. Five hundred cameras of many different types were employed and more than 100,000 still pictures and three million feet of cine-film were exposed during the two tests. Much of the data on the potential destructive force of these bombs will be based on these records.

High-speed cinematography.—It is obvious that a cine-film record is a valuable way of analysing a movement. For many purposes an ordinary cine-camera used at normal speed is quite adequate. Very often, however, it is not convenient to photograph the actual movement itself. When the movements are too small they can be magnified by the use of a follower connected to a suitable dial gauge which is photographed. When they are too complicated, numerous or inconvenient to

record directly, as in the analysis of the performance of an aircraft in flight, dials and cathode ray tube screens which record such data as air speed, altitude, bank and stresses and strains in various parts of the machine can all be collected on one panel which is recorded by a normal speed cine-camera.

New fields are opened up when the camera is speeded up. Phenomena whose life history is too short-lived to be examined by the unaided eye acquire a new significance when the time scale is altered by slow motion (high speed) cinematography. Details of displacement and distortion of objects in rapid motion are directly observable as a function of time when the film is projected at normal speeds while velocities and accelerations can be calculated from frame-by-frame measurements.

Typical engineering applications are the observation of oscillations or surges in valve springs, the hunting of synchronous motors, the functioning of telephone relays, clutches, ringers and dials; coin-collecting mechanisms; contact conditions and the arcing of switches at make-break. It has proved of value in studying such diverse problems as the behaviour of high-speed loom shuttles and observations of warp breakages, the melting of fuse wire during a burn-out and the detection of gas leakage around the charge in a gun when fired. It has been applied to the testing of materials in connection with impact testing, stress analysis and bending moment, and to the reduction of noise in such apparatus as typewriters and accounting machines. Valuable studies from the design point of view have also been made on such relatively slow-moving machines as milling machines and punch and hydraulic presses. Thus it will reveal erratic operations caused by excessive deflections and clearances, and information relating to punch and die adjustment, and to the flow of metal during punching operations.

If the movement to be studied is rotary or rhythmical, it is well known that it can apparently be slowed down by viewing the subject by stroboscopic light of appropriate frequency. A typical example is the study of the flow of air through a fan blade, smoke being fed into the air stream to make the air currents visible. In such cases the record can, of course, be made in an ordinary camera, but the method is of limited application. Genuine ultra-speed cinematography demands radical redesigning of the camera itself, because the film must rush through the camera at about a mile a minute, a speed which effectively rules out the possibility of its normal method of progression—alternate stops and starts.

A laboratory type makes use of an argon-filled discharge tube capable of flashing from 1,000 to 5,000 times per second. No shutter is used on the camera since each flash lasts only 1/250,000th second, and the film does not move appreciably during this period.

In commercial ultra-speed cameras, moving optical devices are built into the camera which send the images formed by the lens streaming along in synchronism with the rush of the film. Thus, for a very brief time, as the film and image flow together, each image is stationary with respect to the film. Perhaps the simplest camera of this type is the Eastman High Speed camera which uses a rotating glass block. Although this camera can record up to 3,000 pictures per second, 1,000 pictures per second is adequate for the study of most machine parts. Naturally, instruments of this type are fairly costly, and since the majority of engineering firms could only

find occasional use for them, it is usual for them to hire the equipment, together with a trained operator as and when required.

Photoelastic Analysis

Many faults in the operation of machines are due to stresses whose existence it is impractical to predict at the design stage. Valuable guidance can, however, often be obtained by the technique of photoelastic analysis.

A scale model is made of the object to be tested, using a suitable transparent material. Loads proportional to those acting on the real object are applied to the model, which is then examined by polarised light. An unstrained model placed between crossed Polaroid screens appears uniformly black under these conditions. Whenever stresses occur, however, the refractive index of the material is altered and bright lines will appear which contour the principal stresses, providing valuable information as to the internal conditions of a similar shaped metal object under similar conditions of load.

If the model is made of a thermo-setting plastic the stress pattern can be rendered permanent by heating the model while it is under load. It can then be cut apart for three-dimensional stress analysis. Calculation of the stresses in all such cases involves measurement of the distribution of the pattern, and this is materially simplified by making these measurements from photographic records—particularly when the stresses are dynamic in moving parts. Here, a cine-film record is the only practical way of assembling the data in measurable form.

Conclusion

This review has been an attempt to demonstrate how certain photographic techniques originating in research laboratories have so far contributed to industrial efficiency.

New ways of harnessing photography as a research tool are constantly being devised, for its powers of exact description are the very foundation of exact knowledge.

It was Eddington who suggested that all that could ever be known of Nature consisted in essence of pointer readings. Certainly the scientific research worker nearly always takes pains to arrange his experiments so that the final observation employs the sense of sight, and the ways in which photography can be used to produce records for visual inspection is limited only by the ingenuity of the worker. Its value for recording invisible radiations is obvious, but even when the eye might appear to be an easier or quicker means of making a record, the camera is often a convenient tool for eliminating drudgery and ensuring accuracy, as when it watches dials, counts dust particles, records, pressures, and so on. Tiny pulsations due to subtle faults in machines can be recorded and enlarged until not only is their presence demonstrated, but measurements which reveal their cause become possible. The differences of refractive index in the laminæ of hot and cold air produced by stringing heated wires across a wind tunnel can be recorded and intensified so that even air currents may be photographed.

In many cases, such as the movement of the light spot on the cathode ray oscillograph, the human eye can only see the movement as a blur of light and the



FIG. 8.—*Belcher Islands (Hudson Bay). Quartzite sediments (white) and lavas (grey).*
(Reproduced by courtesy of W Cdr. Pearce, Dr. A. W. Jolliffe and the Royal Canadian Air Force)

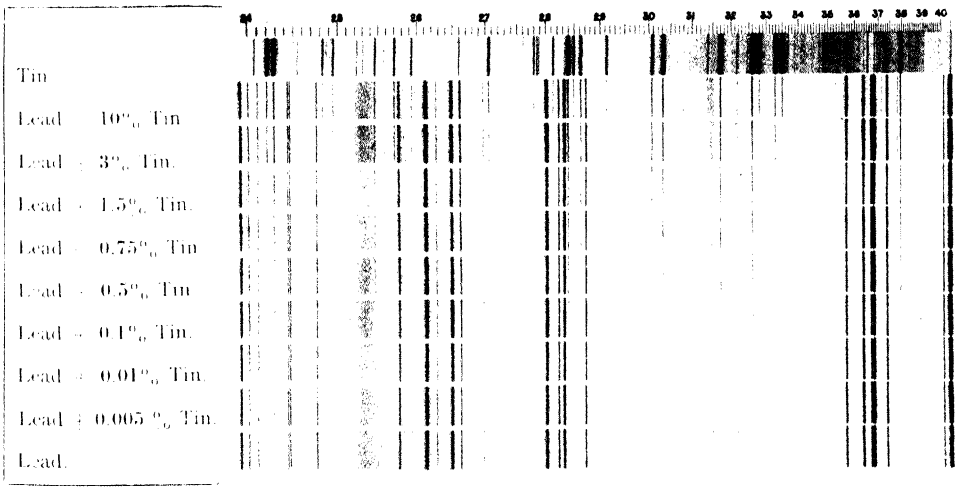


FIG. 9.—*Analysis in a flash. The proportions of the various constituents in a metal alloy as recorded by a spark spectrograph are determined by measurements of the relative densities of the spectrum of each metal.*
(Reproduced by courtesy of Adam Hilger, Ltd.)



FIG. 10.—*Microradiograph of a Copper-Lead-Tin Alloy. The specimen was* 0.1 *in. thick.*

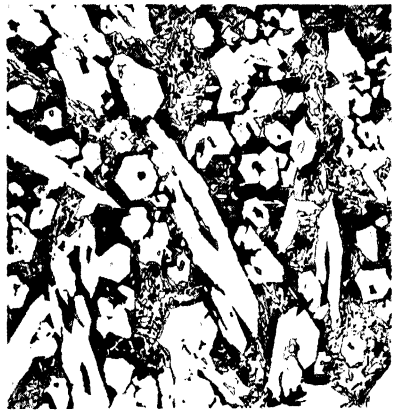


FIG. 11.—*Typical metallurgical photo-micrograph. High Chromium Alloy Cast Iron.* 100x.

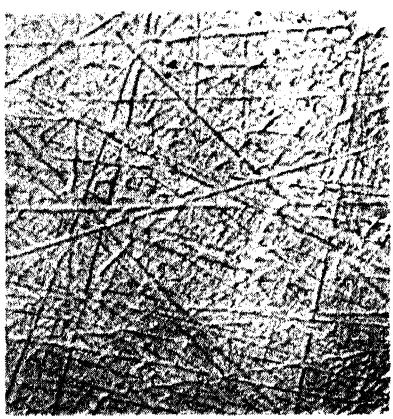


FIG. 12.—*Buff-polished metal-*13,000x. *This is a polystyrene-silica replica of a metallic surface buffed with a chamois wheel and fine rouge. It is interesting to note that a mirror finish on metal actually consists of a myriad of fine scratches.*



FIG. 13.—*One-millionth second flash photograph of oil fuel emerging from a jet.*

(Reproduced by courtesy of the Royal Aircraft Establishment)

moving photographic film is an essential tool for reducing the record to intelligible form. In others, as in the transient tracks produced in cloud chambers by subatomic particles, photography is the only way in which a record can be made for subsequent interpretation and measurement. When the disintegrating atom is embedded in a photographic emulsion the tracks made by its debris of charged particles are produced by direct action on the silver salts. Measurement of these tracks made permanent by development enables the energy and momentum of the various particles to be determined, thus providing the vital key to the interpretation of the atomic explosion. It can therefore safely be claimed that but for photography our hopes of harnessing atomic energy would remain a novelist's pipe-dream.

I think it will be obvious to you that many of the techniques described are highly specialised and can only operate at maximum efficiency when the behaviour of photographic materials under a wide variety of conditions is properly understood and catered for. It is therefore a matter of regret that as yet not one of our leading universities has established either a teaching course or a research department on Photography. In Germany, before the war, nine universities offered training and facilities of the type required, in Japan two and in Italy four, to refer to our late enemies alone. In England such courses as are available are intended primarily for professional photographers; and those enterprising industrialists who wish to make use of this twentieth-century tool for solving one of their twentieth-century problems must as yet rely either on their own resources or the technical service departments of the photographic manufacturers for essential guidance on photography as a record-maker in the widest sense.

However, a committee appointed by the Royal Photographic Society has recommended the establishment of a readership in Photography within a British university. Such a course would be a valuable first step in ensuring a supply of thoroughly competent workers of the type required if we are to take full advantage of this potential contribution to our industrial efficiency.

LECTURE III.—*Delivered May 19th*, 1947

PHOTOGRAPHY IN TRAINING AND EDUCATION

When the modern technician proudly points to the rate at which his command over Nature has been accelerated in recent years, thoughtful people inevitably wonder whether this is as good a thing as the technician would appear to think.

It would certainly seem that modern civilisation has developed a dangerous list, largely as a result of the use we have made of the tools which applied science has placed in our hands. No one would think it wise to give a baby a circular saw as a plaything. Is man in his present state of cultural development any more fit to possess rockets carrying atom bombs?

Generally speaking, the most formidable problems of contemporary society do not arise from limitations in our ability to command the resources of Nature, but from the imperfect co-ordination of human effort—our inability to absorb technological progress quite as quickly as that progress is thrust upon us. We have got to find out in the next few years forms of organisation which will guarantee the

continuance of mechanical civilisation or we are going into the abyss. But if social organisation is to be improved it will be done through learning new habits rather than the breeding of a new sort of man. We shall not achieve world understanding by sudden dramatic change-overs or revolutions, but by an infinitesimal number of imperceptible changes in the way we think, behave and conduct our daily lives. But the sociological behaviour of man is probably influenced as much by the acquisition of habits in childhood as by hereditary constitution. The raising of the school-leaving age on April 1st was a recognition that the three R's with a smattering of science and dead languages is an inadequate school education for the coming generation. How best to fill the extra year of school life is, however, still a matter for debate.

It is a comforting thought to the photographic technician that photography, which has done so much to accelerate man's control over his material environment, is capable, if we so wish, of making equally powerful contributions to his efforts to fit himself for the rational employment of these powers. I refer to the as yet relatively undeveloped applications of photography in all forms of education. New approaches to history, geography, economics and sociology can be immensely simplified and accelerated by the intelligent use in the school of modern forms of the ciné film and the lantern slide. These media will also simplify the problem of giving the child introductory vocational training.

Cine Films

Long before the war the potential value of the cinema as an educational tool was well recognised, but only half-hearted attempts were made to develop its use in this connection. The commercial cinema, whose structure demands that its products appeal to the largest possible audience, has produced very little of genuine educational value. It is true that in the late 'twenties the Empire Marketing Board sponsored the production of a new type of film—the documentary—in which the emphasis was on social analysis rather than entertainment. Only a small proportion of these films covered their cost through cinema bookings, and as the documentary film widened in scope it became primarily the province of the public relation needs of big industrial organisations who sponsored the production of films on subjects as diverse as elementary science, education, housing, child welfare and local administration. Their sales organisations were meanwhile taking an increasing interest in films as a means of sales promotion.

Fifteen years of development had, however, only yielded about 300 documentary films by the outbreak of war. More than twice this number were produced in the following five years by the Films Division of the Ministry of Information, and by 1943 over eighteen million people formed their yearly British audience, half of which saw shows given by mobile projection units.

Sub-Standard Size Films

The commercial cinema uses celluloid film 35 mm. wide. In 1924, however, the Kodak Company introduced a 16 mm. wide film on safety base, primarily to make cinematography possible to the amateur. The subsequent introduction of precision cameras and projectors enabled sub-standard films of quality comparable with the

standard size to be produced, and the majority of the Ministry of Information factual films, though photographed in 35 mm. cameras, were issued as reduced size prints on 16 mm. film.

The Services had made negligible use of films prior to 1940, but by the end of the war production of films made primarily for training purposes had reached 300 a year. The making of films on tactics, gunnery, target identification, equipment maintenance, hygiene, air-raid precautions, and so on, led to the rapid accumulation of valuable experience on all aspects of training film production. It revealed a number of technical problems whose solutions have still to be found, but it proved so convincingly the value of the film as a training and educational tool that only the bottlenecks of apparatus and film production prevented a much wider use of the medium for this purpose.

Many specialised forms of training aid were built round the general principle of cinematography. Thus aircraft gunnery was taught with dummy guns which the trainee aimed at the images of aircraft projected on to an artificial sky in such a way that, when viewed through the gunsight, the illusion of reality was startling. Every time the gun was "fired" it recorded the gunner's ability as a marksman. Navigation of aircraft was taught in dummy cockpits suspended above a floor on which moving photographs of the landscape were projected.

It is impossible to estimate how many lives realistic training of this type has saved, but it is certain that when the typical pilot went into action for the first time he was already experienced in a way that the First World War flyers rarely lived to achieve.

Sometimes, as in the case of the R.A.F. gun camera, 16 mm. films were of value for both record and training purposes. Air combat began in the 1914–18 war with the airmen taking potshots at each other with pistols from aircraft travelling at motor-cycle speeds. In 1944 they were firing cannons at each other while travelling at speeds approaching that of sound. Before you can let a man loose with weapons like that you need to be very sure of him, and the gun camera made this possible. In his early training this specialised form of 16 mm. cine-camera recorded his target whenever he pressed the trigger release of his guns. In actual combat the same camera was mounted alongside the weapon with lens and gun barrel harmonised. Had we known when gun cameras were first introduced that they would eventually be required to operate efficiently when rigidly clamped next door to cannons, the lens to look through showers of oil, smoke and soot at an enemy perhaps 1,000 yards away, we should have been pessimistic as to their performance. But the necessary modifications just managed to keep pace with armament progress, and the resulting films not only provided irrefutable evidence on which reliable combat claims were based, but were invaluable guidance to the fighter pilots for future combats.

When the war came to an end the value of films as a medium for conveying information, for reporting and record and for general education and training was thoroughly well established but, in the case of 16 mm., a large proportion of the available equipment was worn out in the process. We have therefore to mark time until the present bottleneck of adequate supplies of film and equipment is resolved. At first sight this would not necessarily appear to be as big a drawback as might be thought, for our ideas as to how best to use the sub-standard film in education still

require clarification and industry's present problems are not so much the development of new selling aids so much as the production of an adequate volume of goods.

INDUSTRIAL TRAINING

It must not be forgotten, however, that many of the techniques for speeding up training developed during the war are, in so far as the means are available, directly applicable to increasing the industrial efficiency of our workpeople. A typical job raining programme involves actual demonstrations and lectures in the workshop.

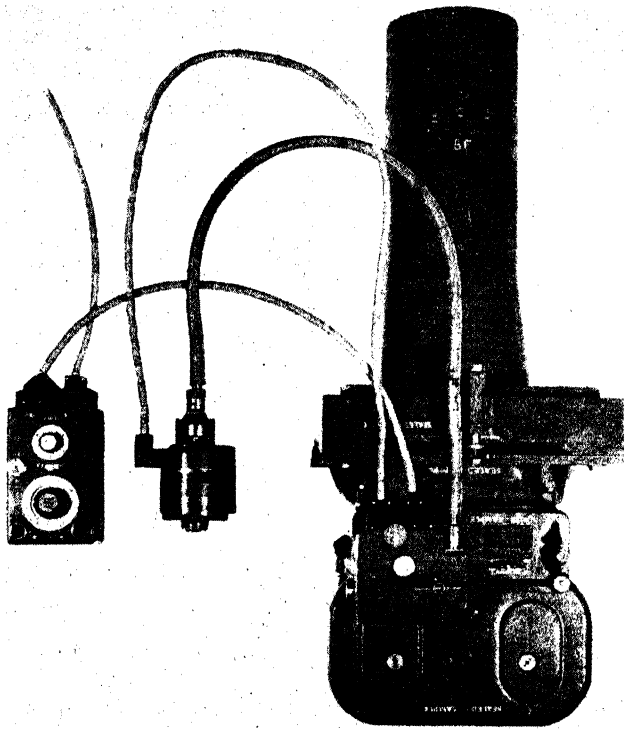


FIG. 14.—*The F. 52 Air Camera, fitted with 36-in. focal length lens, as used by the R.A.F. for photographic reconnaissance.*
(Reproduced by courtesy of the Royal Aircraft Establishment)

Surrounded by the distracting clatter of a busy shop, instructors endeavour to explain key points of an operation to a new employee. The latter is often confused by the varying techniques used by different instructors and the inessential equipment and noises which surround him. By using still photographs it becomes possible to give coherent instructions based on close-up views and explanatory diagrams in a more convenient environment. By using cine-films a coherent course of training directed to each individual in large groups and demonstrating moving parts is possible.

MOTION ANALYSIS

Unfortunately, there are as yet nothing like enough projectors available to embark

on adequate industrial training schemes involving the study of films by the workers concerned, but the cine-camera is hard at work assisting the time and motion study engineers.

I referred in the second lecture to the use of the cine-film for analysing the



(*a*)



(*b*)

FIG. 15.—*Micro-motion study of the collation of documents.*
(Reproduced by courtesy of W. H. Smith & Sons, Ltd.)

motions of machinery. Cine-records of the movements made by workers engaged on repetition jobs can be analysed in a similar manner in order to determine the most efficient and least tiring sequence of operations. As an example, a step-by-step analysis of a timed cine-record of a girl sorting spools led to the devising of a method which increased her output 80 per cent. The sorters find the new method less tiring and, being paid on an output basis, everyone profits by the change.

It has been suggested that making such records on infra-red sensitive film would have the psychological advantage that the worker would not be disturbed by the obvious presence of a flood of additional lighting which is necessary when ordinary cine-film is exposed in typical workshops. The recent spectacular increase in the working speed of infra-red emulsions makes such a proposal quite feasible.

For the so-called "micro-motion study" of repetition movements a cine-record is not necessary. Instead, small lamps can be attached to the moving parts of the operator's body, their light being then recorded over one cycle of the operation by working in a dimly lit room while the camera shutter is left open. If the lamps are made to flash at a uniform rate, the speed of the operator's movements can be calculated as well as their path. When two hands are employed—as in the case illustrated in Fig. 15(*a*), saw-tooth modulations of different types can be employed in each lamp to facilitate sorting out on the photograph of the movements made by each. The figure shows a girl collating the sheets of a manuscript. The movements made by her hands along the desk are revealed by the intermittent light trace. The greater smoothness of movements, speed and economy of effort resulting from a rearrangement of the positions of the various piles of paper is seen in Fig. 15(*b*). Messrs. W. H. Smith used this technique to study the movements made by a typist in making out invoices. This led to a rearrangement of the data on the form, which reduced the time of typing each form by two-thirds.

Here again, by working in a room lit with fluorescent light—which contains no infra-red radiation—the lamps attached to the worker's wrists can be covered by visually opaque infra-red transmitting filters and the record made on an infra-red emulsion. This adaptation of a war-developed technique used in training the pilots of night fighters has the advantage that the operator can work under normal illumination conditions and with a minimum of distraction due to the presence on her wrists of the recording lamps.

Educational Films

In America, where the equipment shortage is not so acute, the chief industrial use made of 16 mm. film is as yet in the fields of sales promotion and public relations. The majority of American industrial training films would appear to be intended for sales staff and associated distributors and dealers. There is however a growing interest in the direct training of workpeople by the use of a projector installed alongside workshop machines. These projectors carry an endless loop of film so that the operation being taught is repeatedly demonstrated without any attention to the projector. It is probable that such methods will not make much headway until projection devices more convenient than the present types are specially designed for such use.

Of more far-reaching importance is the value of the film in schools, and after a number of false starts our ideas on the place of the film in the school curriculum are beginning to crystallise. In the past, Germany, America and Russia have been far more enthusiastic in their approach to the film as a school aid. Thus there were in 1939 more projectors in the schools of Hamburg than in all the schools of Britain. In America to-day, 24,000 schools and colleges have between them 20,000 projectors for showing 16 mm. sound film, and it is estimated that there will be a minimum

of 100,000 in the near future. In English and Welsh schools we have as yet only 400 16 mm. sound projectors and perhaps 1,000 silent machines, mostly old and worn out. This does not necessary mean however that the British school child has as yet been at any serious disadvantage, for the number of teaching films really suitable for school use which have so far been produced in any country is surprisingly small. The majority of those made in England have been produced by private enterprise and the public relations departments of industrial organisations, and for the most part they provide at most backgrounds to the lessons rather than the lessons themselves. Many teachers indeed consider that this is the proper function of the film and would resent anything which appeared to mechanise the processes of education.

This attitude may alter as films of more suitable type become available. The majority of present-day educational films are too long and they often cover more than can be absorbed in a single lesson. They frequently contain irrelevancies, unnecessary background music and a semi-facetious commentary which becomes intolerably irritating as the film is repeatedly studied.*

These drawbacks are primarily due to the fact that a film is an expensive thing to produce, and in so far as it is Ministry of Education policy to leave their provision to private enterprise, the makers must have a wider public than the schoolchild for the production to be worth while from their point of view.

The enterprising teacher on the other hand would probably welcome what Meredith† has called sentence and paragraph films—simple but well-made illustrations of single aspects of a subject and lasting not more than a minute or so. Such films would, unless the subject was music or a language, usually be better if silent and, if the facilities were available, would often best be made by the teacher himself. When elaborate animated diagram work is involved, however, a really convincing sentence film is difficult to make without proper equipment and skilled technique, and the pioneer efforts of Messrs. Dance Kaufmann in this field are therefore to be commended. (*A Demonstration of a looped diagram film showing the principle of the cyclotron was given here.*)

Recently the Ministry of Education has sponsored as an experiment the making of four so-called visual units. A visual unit may comprise any or all of the following methods of presenting a subject: A sound film, a silent film, a series of lantern slides (often in the form of a 35 mm. film strip), photographs on paper and wall charts, together with teaching notes. Made with the co-operation of teachers, the reception accorded to these units will be significant, though as yet few schools have facilities enabling them to use the units in a suitable manner.

Film Strips and Film Slides

A sound film projector is an expensive piece of equipment which requires intelligent maintenance. Silent projectors, although cheaper and easier to operate, are also in short supply, and it is probable that for some time to come the film strip and the film slide will be the most widely used of the "projected image" types of

*A notable exception is the well-known "Secrets of Nature" series of which special teaching versions, free from "wisecracks" are made by Gaumont British Instructional Films for biology classes.

†Visual Education Centre, University College of the South-West, Exeter.

visual aid. The film slide projector is only the familiar magic lantern in a far more convenient and economical form. With it the instructor can hoist instantaneously into position on the classroom wall a succession of photographs, charts and diagrams 20 square feet in size, whisk them away at will and store them in unbreakable form in next to no space, merely at the cost of slightly darkening the room. Here again, it was war-time urgency in the training of soldiers, sailors, airmen and the Civil Defence services generally which provided the necessary background of experience on which the value of the miniature lantern slide projector as a training aid has been established.

The typical film strip is a series of lantern slides produced in sequence on a length of 35 mm. film, whereas film slides are individual 2-inch by 2-inch lantern slides usually made by framing individual 35 mm. photographs,* and modern 35 mm. still projectors will accommodate both forms. The film strip has the advantage that a coherent sequence of pictures and explanatory titles can be produced in the cheapest possible form. Together with an appropriate teaching manual it is very suitable when the instructor is only slightly more familiar with the subject than his pupils and deviations in the manner of presentation would be undesirable. Indeed, by recording the commentary on gramophone records an instructor as such is not always necessary. In the "Synchrophone" mechanisation is complete, for superposed on the recorded commentary are inaudible supersonic signals which initiate the automatic changing of the pictures at the appropriate points.

This form of mechanical visual aid should be suitable for museums, exhibitions and as industrial training and sales aids where there is no objection to mechanising the instruction. Thus in teaching the sequence of operations in bench work or machine work the sound slide film may well do a better job than a busy foreman. Generally speaking, however, the school teacher naturally looks askance at ready-made instruction of this type, and the flexibility of a collection of film slides is a great advantage. Not only can the slides be arranged in the order the teacher prefers, but replacements and additions are obviously easier to make than is the case with the continuous film strip.

It will frequently be desirable to include slides made by the teacher himself, and simple frames have been designed into which a miniature camera can be fastened to facilitate the making of the negatives. A typical device for making close-up records carries an electric light source and a wire frame supported in front of the camera lens at the position of exact focus. This frame is placed against the subject and a fixed exposure given. A book *How to repair a bicycle*, which consists entirely of captioned photographs of the various operations recorded in this way has already been published. The device can also be used as a fixed focus copying camera for preparing from existing photographs and diagrams either film slides or film strips.

A convenient accessory to a miniature projector is an automatic slide-changing mechanism operated *via* Bowden cable, which permits the teacher standing near the screen to change the picture in the projector at the other end of the class room.

One disadvantage of projected visual aids in the classroom is the necessity for darkening the room somewhat. This makes note-taking awkward and discipline

*The nomenclature used here is that employed in British Standard Specifications. Some prefer to call film slides "miniature lantern slides".

more difficult to maintain. Recently a new type of projection screen has been designed which enables high-quality projection to be made in ordinary room lighting. The screen is built up of small spheres of plastic joined by a black matrix and viewed from the front it appears to be a dark grey sheet. When an image is projected on to the rear of this screen the light falling on each transparent sphere can only escape through to the front *via* the small area not masked by the black surround. The image as seen from the front therefore consists of innumerable points of light which are too small for the eye to resolve while its range of contrast is close to that of an image projected on the conventional white screen in a dimly lit room.* Viewed from directly in front of the screen there is very little to choose between this new form and a conventional back projection translucent screen in which the "hot spot" has been avoided. Viewed from an angle however—and this is how the majority of the audience must inevitably view projection screens—the improvement is striking. Incidentally, the efficient ventilation of the room is simplified when such daylight screens are employed.

Presumably the classrooms of the future will be so planned as to facilitate the convenient use of projected teaching aids, and information is already available on such requirements as the optimum ratio of picture size and brightness to the seating plan, the size of viewing angles with the different forms of screen, and so on, which will guide the architect who has a free hand. For many years, however, we must make the best use we can of existing facilities with which there is still ample scope for experiment. Thus in certain R.C.A.F. teaching units a section of the "blackboard" was painted with a white paint to form a projection screen. When a line diagram was projected on to this screen the instructor could amplify his remarks by the use of coloured chalks to add to the diagram as the various points were made.

The conventional arrangement of a classroom is to place the blackboard in the middle of the end wall. This, however, is not necessarily the best position for a projection screen. By placing this screen across one of the corners, it is possible by slightly displacing two of the scholars to give the whole class an unobstructed view of the screen.

One can picture, then, a course of instruction in the future being supported by:

(*a*) Lesson films—short, silent, 16 mm. films usually an explanation in dynamic form of some principle of experimental technique.

(*b*) Revision films for introducing or summarising some aspect as a whole rather than the part.

(*c*) Factual films, which may be sound or silent, linking scientific principles with the outside world and which carry on where the blackboard and lantern slide stop.

(*d*) Film strips with teaching notes in all those cases where 16 mm. films of type (*a*) and (*b*) are unnecessary, unobtainable or too costly.

(*e*) Film slides—some at least of which may have been made by the teacher or the students.

As the supply of films and film slides which teachers themselves are helping to produce rises in volume one can expect such opposition as at present exists to these

*Screens of this type are not yet commercially available, though experimental forms were in use at an exhibition of applied photography held in London at the time of this lecture.

forms of visual aid to disappear. In any event most of the new generation of teachers now under course of training are well aware of the powerful help properly made visual aids can be, for they came into contact with them while in the Services.

As witness to the magnitude of the visual aid training effort made by the armed forces, one production unit in Canada produced over two million film slides for the R.C.A.F. during the war, and the U.S. Army possessed forty thousand 16 mm. sound film projectors by V.J. Day—none of which can as yet be spared for civilian purposes. I do not know if the amount of visual aid equipment used by the British armed forces has been published, but the experience of the Training and Staff Duties Division of the British Admiralty in the use of 16 mm. films and of film strips has been made available in two valuable pamphlets issued on behalf of the Inter Services Training Committee for the guidance of instructors. As a result many thousands of potential teachers have had forcibly driven home to them that words are only a complicated form of picture and that in many cases the image itself makes a more direct and permanent impact on the mind.

With such aids the rural school will gain even more than those in towns, for, in extending the child's mental environment, they will provide a link with the outside world and overcome the sense of isolation still common to the child educated in the country. They will assist the town child as well as the adult to cope with the avalanche of knowledge that is swamping us. But visual aids need not mechanise school life, for no machine can take responsibility whatever else it may do, and instead of the good teacher losing initiative he will be gaining new power. Only in the case of the sound film—the most expensive form of visual aid—is there any risk of instruction becoming dogmatic. Those who condemn sound film as therefore more suitable for propaganda than education presumably realise that the other forms of visual aid, in that they can be accompanied by any form of commentary the teacher wishes, are potentially just as "dangerous". If we distrust tools because they can be mishandled we must regret that we are living in the twentieth century Personally, I think greater familiarity with what can be done will do much to allay such fears of visual aids as have been expressed, and that in some fields the teacher of the future will welcome mechanisation of certain aspects of teaching. In addition to becoming a valuable supplement to the "chalk and talk" form of education photographic visual aids will make types of education and training practical which nowadays demand highly specialised knowledge or monotonous drudgery from the teacher. As a simple example, silent cine-films are already used as infinitely patient teachers of lip reading to the deaf. As often as necessary and at the optimum learning speed the image on the screen mouths the words which the deaf students write down.

But this is only a beginning which in years to come may well seem as primitive as Hero's steam engine. It is possible to imagine a slow-motion, natural-coloured, stereoscopic sound film consisting of the best elements of the skill of a hundred different masters acting as a consummate model excelling the performance of any human individual and which could be used to impart that skill to the whole world.

One can imagine new forms of projector devised to teach, for example, such arts as piano playing—and later the technique of particular pianists. Picture an instrument as simple to operate as a metronome which projects on to the keyboard images of the master's hands showing his fingers executing each note. The silent

phantom might prove a better instructor than the master himself as the looped film patiently repeats its lesson faster and faster as skill develops. It does not require a very vivid imagination to appreciate that if cinematography continues to advance during the next fifty years at the pace it has set for itself it may easily become the supreme habit educator of our race, summing up in its records the experience of the world, so that no new knowledge is lost and our grandchildren may all begin at the highest point of skill their fathers had attained.

Meanwhile, however, the cinema industry has yet to free a much greater part of itself from the mental outlook of the fairground showman if it is to help us in the race between education and disaster; while present-day British teachers are not as yet assured of adequate supplies of the simplest type of film slide projector.

It is unfortunate that so much still remains to be done, for we are lagging far behind America and Russia in our development of photographic visual aids. It is welcome news that the Ministry of Education has formed advisory committees on the subject, for in many respects we are all necessarily waiting on a Government lead. Thus the makers of the various types of projection equipment are tooling up or in production with a variety of forms of apparatus, some of which may eventually require modification if they are to pass an, as yet, unavailable official specification of minimum requirements. At the moment the per capita grant per scholar for all forms of visual education made by the Ministry of Education is 2*s*. per annum, while with the exception of the four experimental visual units referred to and a couple of teaching films on simple cookery, the provision of the films and slides has so far been left to private enterprise. Unlike a textbook, however, the teaching film is an expensive thing to produce and difficult to revise. Its distribution is limited by the inadequate projection facilities as yet available and its make-up is still a matter for investigation. All these considerations indicate the need for official sponsorship or, as a minimum, greater encouragement of those pioneers who despite burnt fingers are still determined that we shall all profit by our potential ability to put knowledge we have to acquire into the most easily assimilated form.

(At the conclusion of the lecture the lecturer performed a conjuring trick with string before the audience. He then showed a slow-motion cine-film which revealed how the trick was performed. He then provided members of the audience with pieces of string and used a series of stills from the film in the form of a film strip to take them step by step through the trick, thus demonstrating the value of the slow-motion film in solving a problem and the film strip in the teaching of a series of movements.)

ACKNOWLEDGMENTS

The thanks of the author are tendered to the following firms for the loan of equipment placed on display during the lectures:

British Industrial Films, Ltd.
Daily Mail (Visual Aids Dept.).
Dufay-Chromex, Ltd.
G.B. Equipments, Ltd.
Kodak, Ltd.
Ministry of Supply.
Newton & Co., Ltd.
Pullin Optical Co., Ltd.
Royal Canadian Air Force.
Williamson Manufacturing Co.

His thanks are also due to Mr. E. R. Davies, Director of Research, Kodak, Ltd., and his colleagues, G. A. Jones, B. Macalpine, P. H. G. Wall-Row, T. I. McGloughlin, Glenn Matthews, D. Stewart, T. Shapira and L. Mullins, of the Kodak Research Laboratories for assistance in the preparation of illustrations and demonstrations.

GENERAL NOTES

EXHIBITION OF DESIGNS SUBMITTED FOR THE PROPOSED CATHEDRAL OF THE HOLY CROSS, COLOMBO, CEYLON.—The Exhibition of the designs submitted in this competition was held in the Society's Library from August 25th to 30th. Considerable public interest was aroused by articles and photographs in the daily and technical press, and the Exhibition was visited by some 400 members of the public.

The Assessor's report and pictures of the winning design will be found in the *Journals* of May 9th and May 23rd.

APPOINTMENT OF MR. GORDON RUSSELL AS DIRECTOR OF THE COUNCIL OF INDUSTRIAL DESIGN.—It is with great pleasure that we announce the appointment of Mr. Gordon Russell, C.B.E., M.C., R.D.I., F.S.I.A., as Director of the Council of Industrial Design.

This appointment is a recognition of the desirability of filling that post not only with a practising industrial designer but with a business man as well. Gordon Russell is both. He needs no introduction to the Fellows of this Society. As this year's Master of the Faculty of R.D.I., to which he was elected in 1940, he sits on the Council of the Society.

It is perhaps well to remind ourselves that the full title of R.D.I. is " Designer for Industry of the Royal Society of Arts", and that election to this limited Faculty is made by the Council of this Society. No greater honour can be bestowed on an industrial designer and this in itself is sufficient recognition of Gordon Russell's qualifications in his chosen vocation.

As a business man Gordon Russell has been a very successful furniture manufacturer, and most modern radio cabinets inevitably show the influence of his original basic design for one of the well-known radio firms.

This combination of business man and industrial designer in one who has travelled widely, written much and broadcast frequently on the subject which he has so passionately at heart should make Gordon Russell's directorship of the Council of Industrial Design a most successful one.

NOTES ON BOOKS

FIVE ARTS. By F. E. Halliday. Duckworth, 1946. 12*s.* 6*d.*

Mr. Halliday has written a sensitive book. The fact that his main æsthetic plank will no longer bear much weight, does not invalidate the quietly appreciative comments on painting, sculpture, architecture, music and poetry, with all of which he deals. The author's main concern is to approach an appreciation of poetry by way of analogy to the other arts, with any of which the reader may be either more familiar or more in sympathy. He claims, not unjustly, that this method has the advantage that it may arouse an interest in, say, painting or music, for their own sakes, as it were, *en route*. Unfortunately, in the space at his disposal, Mr. Halliday's chapters on the individual arts are apt to become potted histories, having the appearance of being included to illustrate his points, and I should like to have found more analysis of individual works, and less catalogue of names, periods and styles.

It is stated that the main quality common to all works of art, irrespective of the chosen medium of expression, is a formal basis, and that all other qualities are not only irrelevant but distracting. In other words the book is a claim for the consideration of the work of art *per se*, and independently of associations in the mind of the spectator due to subject matter. In a disarming preface, Mr. Halliday disclaims any intention of finality or dogmatism; nevertheless he does not discuss in any detail other æsthetic systems, and does in fact proceed to evaluate works of art in terms of their abstract formal significance, clearly convinced of the essential validity of his æsthetic yardstick.

The pre-eminence of form over content, of the Platonic view rather than the

Aristotelean, is essentially a classical concept, and one much to the fore until the recent war. Mr. Halliday merely extends to poetry the principles which Roger Fry and Mr. Clive Bell formulated for the visual arts, and had this book been written twenty years ago it might have been a revelation to many people who may well pass it by in 1947. For æsthetic theory, like art itself, is subject to the fast fluctuations of fashion, and the concept of "significant form", having leavened all our ideas about art and established its gods (Poussin, Cézanne, Picasso, Cubism), is now a receding tide. This does not mean that the theory is invalid, it merely means that objections to it now spring more readily to mind. Form was the battle cry of the 'twenties and 'thirties, but content bids fair to re-establish its former position.

Mr. Halliday says: "The point is this: that music and literature may be intensely moving, the one directly evoking ordinary (*sic*) pleasurable emotions by its sound, the other indirectly by the representation of its story, and that these emotions may be mistaken for the æsthetic, whereas the æsthetic emotion is distinct from all other emotions and is moved directly by the form". This statement fairly bristles with difficulties, too many to discuss here, but it may be said that in the reviewer's opinion it seldom proves desirable to attempt a separation of the complex elements which go to make up a work of art, and in the majority of cases no real or adequate separation is possible. It is too fatally easy to assume that the artist's prime interest has been in design or form, and that the representational or evocative elements are irrelevant additions which, as it were, sugar the bitter formal pill for the spectator. Neither is it wise to try to limit the artist's function, for however great his ability as a designer, yet he may be psychologist, mystic and storyteller too. True that an intended work of art without form as a matrix for the content, can hardly succeed, yet granted that basis, the work of art may be inspired by all kinds of phenomena as well as the formal. Form without content leads if not to sterility then at least to aridity, and many of the experiments in pure form of recent decades belong perhaps to "a laboratory of art" rather than the world of human values. Unlike Mr. Halliday, I respect the pleasures of recognition and the communication of emotion, and I am even disposed to see in them æsthetic values. I cannot grant that formal values are the only ones correctly called æsthetic.

Mr. Halliday does go some way to meet me by allowing to elements other than the purely formal the title "secondary æsthetic effects". The trend of modern theory is increasingly to allow for these secondary effects, and to attach progressively less importance to purely formal elements. Even while Roger Fry was so persuasively urging us to adopt the one attitude, the other was getting new impetus from the surrealists and cutting the ground from under his feet. To illustrate from the sphere of recent English art, let us take the sculpture of Mr. Henry Moore, which at first was admired for its strong formal simplicity. It is now being associated with the Romantic art of Mr. Sutherland and the many young artists enrolled under the banner of a new romanticism on which are blazoned the names of Blake and Samuel Palmer, and even lesser names such as John Martin, who would not have been greatly appreciated, one supposes, by Roger Fry. In addition to surrealists and romantics, there has been in English painting the rise of realism, led by Mr. Pasmore and Mr. Coldstream. Each school, in its way, attaches importance to content, subject matter, representation, or emotion; and thus does the edifice of significant form dwindle in stature.

To each chapter of this book, the author appends well-chosen quotations which form an admirable anthology of poetry and verse, and writings about art by artists and critics. This interesting anthology might deserve separate publication. The illustrations are over-familiar, and I may say here that the dust jacket is deplorable, and indeed the book will not appeal to the really well-informed reader. But to others it will serve as an excellent introduction to the arts in general and to poetry in particular, and if I may say it without offence, as a good cultural text-book for sixth forms.

LEONARD GREAVES.

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ENZYMES: THEIR ISOLATION, STRUCTURE, USES, MODE OF ACTION AND PLACE IN NATURE

By J. A. V. BUTLER, D.SC.

Courtauld Research Fellow, Courtauld Institute of Biochemistry

CANTOR LECTURES

LECTURE I.—ISOLATION AND NATURE

Reactions effected by enzymes must be among the oldest used by mankind. One has only to think of the many fermentation processes used in an agricultural or pastoral economy, such as cheese making, baking, brewing, making wine from the juice of the grape and making other fermented liquors, all having origins predating civilisation.

It was not until chemistry was fairly well advanced that such processes became clearly distinguished from other types of chemical reactions. Kirchhoff in 1811 recognised that malt contained a substance which solubilised starch. Schwann, the originator of the cellular theory of living things, named the characteristic ferment of the stomach, "pepsin". Later on a distinction was made between "organised ferments" such as yeasts, in which Pasteur maintained that the whole organism was necessary to bring about fermentation and "unorganised ferments", like trypsin and rennin, in which the fermentative principle could be obtained apart from living cells. This distinction was done away with by Buchner, who showed in 1897 that cell-free yeast extracts could bring about alcoholic fermentation.

The name *enzyme* (meaning "in yeast") was given by Kühne in 1878 to biological agents which can bring about chemical changes outside the cell—biocatalysts in short. Their nature remained for long completely obscure, notwithstanding many attempts to purify and isolate them. Willstätter, for example, working in the 1920's, went on "purifying" his solutions until in some cases nearly all the chemical tests were negative, but they still showed enzyme activity. The reason for this was that, on the whole, tests of enzyme activity are frequently more sensitive than chemical tests for the material of which the enzyme is made. This work gave a false idea of the inaccessibility of many enzymes.

ISOLATION AND CRYSTALLISATION

An extraordinary change has come over the subject since that time. Now new enzymes are being isolated every month, and frequently by extremely simple means —at least, simple when known, but often very troublesome to discover. This success is due mainly to the recognition of the enzymes as proteins, so that, knowing what to look for, the chemists have a good idea of the proper kind of preparative procedures. The methods are in fact the methods of protein chemistry—which on the whole differ very widely from those used in other branches of chemistry.

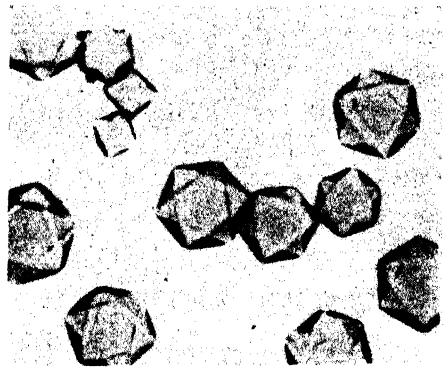


FIG. 1.—*Crystalline urease (Sumner)*

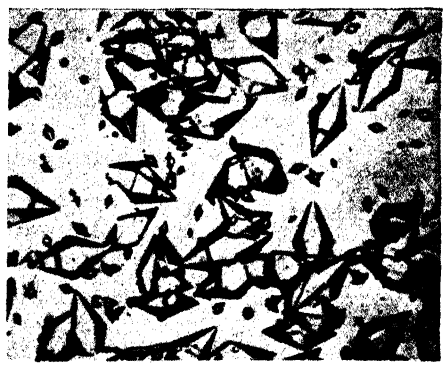


FIG. 2.—*Crystalline pepsin, the digestive enzyme of the stomach (Northrop)*

The first success was achieved by Sumner of Ithaca, who found in 1926, after years of effort, a simple process by which a substance could be crystallised from the jack bean, which had an extremely powerful action on urea (Fig. 1). It appeared to be a pure substance and was, in fact, a protein. A few years later, in 1930, Northrop at Princeton purified and crystallised pepsin (Fig. 2), using as his source mainly the crude medicinal preparations of pepsin, and in 1932 Northrop and Kunitz obtained trypsin, the ferment which continues the digestion of protein in the more alkaline environment of the intestine, from extracts of beef pancreas (Fig. 3). Both of these substances were proteins.

PROTEINS

Perhaps I may be permitted to explain at this stage, for the benefit of those who are not chemists, that proteins are complex nitrogenous compounds, which are invariably found in living things. They are the most characteristic of vital substances and many organisms are largely composed of them. Familiar examples are the

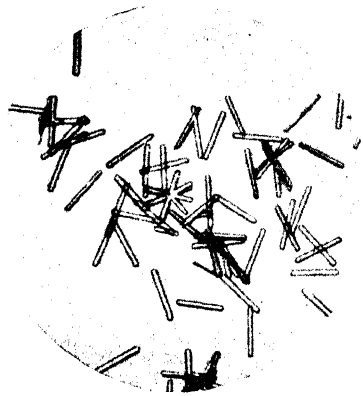


FIG. 3.—*Crystalline trypsin, one of the enzymes which digests proteins in the intestine (Kunitz and Northrop)*

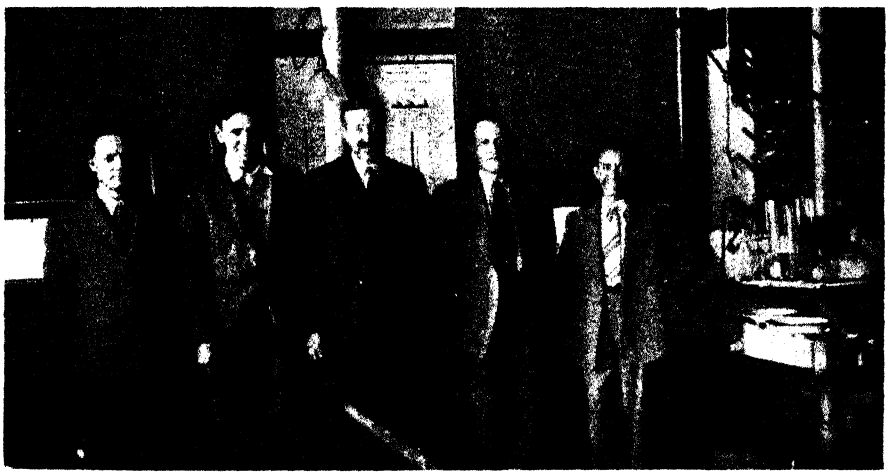


FIG. 4.—*Group of workers on enzymes in Dr. J. H. Northrop's laboratory at Princeton. Left to right: M. L. Anson, R. M. Herriott, J. H. Northrop, V. Desreux, M. Kunitz*

hæmoglobin of blood, the plasma proteins which are obtained by drying blood serum, the casein of milk, the albumin of egg white, gelatine from bones, and muscle protein, which is the main constituent of meat. They are mainly made up of *amino-acids*, substances (Fig. 5) which have the properties both of an acid and a base, and which are able to couple with each other, the acid group—COOH of one molecule joining with the basic group $—NH_2$ of the next, with the loss of a

molecule of water. They have, as it were, two hands and the left hand of one molecule joins the right hand of the next, and in this way long chains can be built up. They consist of a backbone of repeated units —CO—NH—CHR—, with a side chain R, which is often quite bulky, sticking out from the third member. Fig. 6 shows a model of the actual dimensions of the groupings given in Fig. 5. Chains of twenty or more

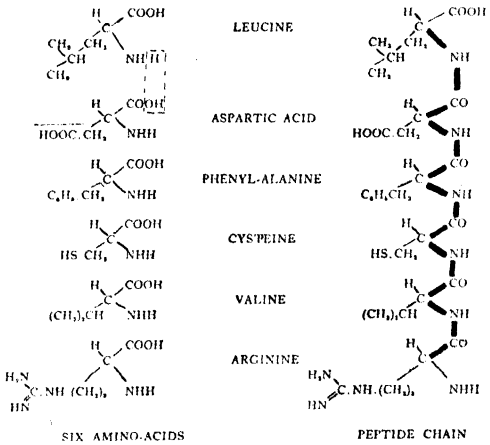


FIG. 5.—*The chemical formulæ of a number of amino-acids and the peptide chain formed from them*

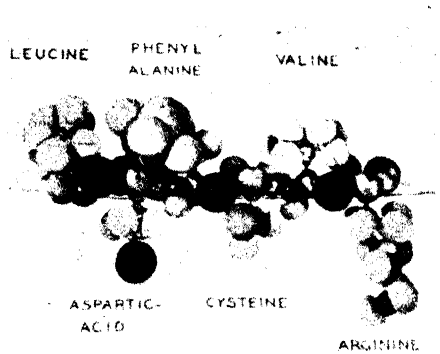


FIG. 6.—*Model of a Peptide (Neurath)*

amino-acids were synthesised by Emil Fischer, but this is still far from anything resembling a protein.

It is in fact only in the last two decades that definite proof has been given that a protein consists of definite molecules, all of the same construction. Before then they were usually thought to be rather indefinite assemblages of amino-acid chains, forming colloidal aggregates. Sörensen subjected the serum albumins to a fractionation process and found that no matter how many times it was repeated he always got two fractions with different properties, so that he concluded that the protein was a mixture of molecules of many different sizes. We now know this is due to the difficulty of finding an effective fractionation process for some of the natural mixtures of proteins.

The work of Svedberg, with the ultra-centrifuge, established that there are proteins having molecules all of the same size so far as the apparatus could distinguish. In other cases he found, not an indefinite range of molecules, but two or three clearly separated sizes, and in these cases methods of separating the constituents have often been found.

This work is perhaps the most significant physico-chemical work of our time, in its implications and in the tremendous fields it has opened up. It not only established the natural unit of the most important constituents of living matter, but it also showed that organised chemical structures exist in profusion, of a much larger magnitude than had previously been suspected.

Other and sometimes more powerful methods of testing the homogeneity of protein preparations have been developed, *e.g.*, the electrophoretic method of Tiselius, in which proteins are distinguished by the rate they move in an electric field, and the solubility method of Northrop and Kunitz which applies the simple

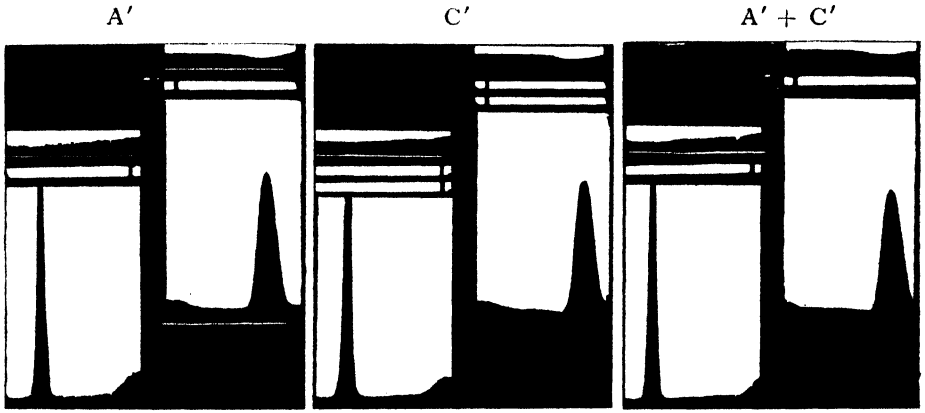


FIG. 7.—*Electrophoresis diagrams of extreme fractions A′ and C′ obtained in an attempt to fractionate chymotrypsinogen, and a mixture of them. A single sharp peak at both the cathode and anode boundaries indicates a single protein component. In each case the left-hand peak is that obtained at the cathode and the right-hand peak the anodic one (Butler and Rothen)*

phase rule test that the solubility of a single substance does not vary with the amount of solid present. A number of proteins (including some enzymes) have been purified to a point at which they show homogeneity by all available tests.

Chymotrypsinogen, a protein found in the beef pancreas, which is the precursor of the enzyme chymotrypsin, is one of the best of these. It has been recrystallised many times without apparent change. An attempt to fractionate it by numerous recrystallisations was made and finally two fractions were obtained, the first A′ from the crystals which had always separated first, and a second, C′, from those which had always separated last. These were examined in the Tiselius apparatus and, after electrolysis for several hours, both had a perfectly sharp single boundary (as shown by one sharp peak in the diagram, Fig. 7) and a mixture of the two was indistinguishable from either singly. In the same way, the solubility of C′ was constant from the first appearance of the solid phase, while A′ showed signs of

containing some impurity, not detectable in the electrophoresis apparatus (Fig. 8).

The molecular weights of some typical enzymes and other proteins are shown in Table I, the smallest molecule so far found as an enzyme being ribonuclease (Fig. 9), having a molecular weight of about 15,000—that means that the molecule contains about 120 amino-acid "residues", as they are called. The molecules of most enzymes which have so far been measured are from two to six times as large. but some are ten or twenty times as large, so that the range of sizes is considerable,

Proteins often contain about twenty different amino-acids, many of which are difficult to determine, so that even their analysis is a difficult matter. New methods

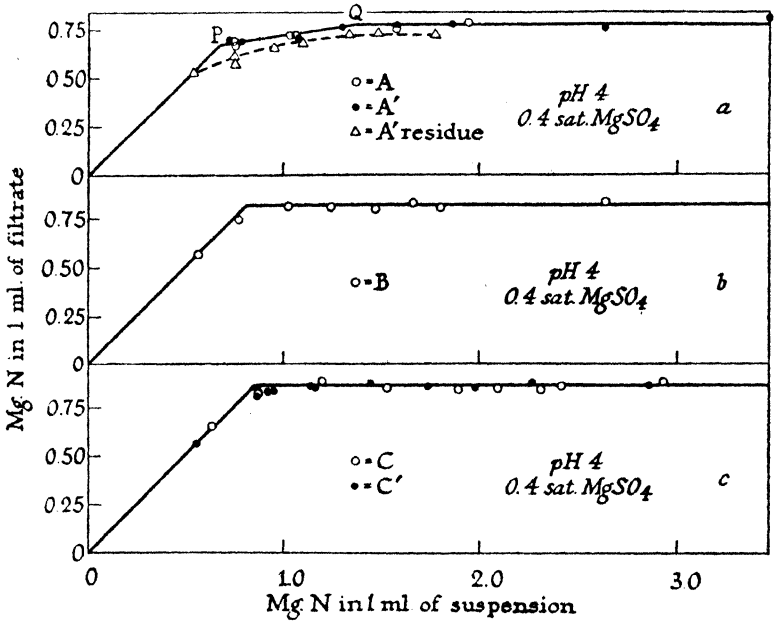


FIG. 8.—*Solubility curves of different fractions of chymotrypsinogen: A,A' and C,C' were the extreme fractions of two different fractionations; B an intermediate fraction between A and C (Butler)*

have been developed, which are very helpful; for example, the use of special micro-organisms the growth of which are proportional in suitable culture media to the amount of one particular amino-acid present; and the use of the newly available radio-active elements to label one particular amino-acid so that its separation can

TABLE I

MOLECULAR WEIGHTS OF ENZYMES AND OTHER PROTEINS

Ribonuclease	15,000	Yellow Enzyme	82,000
Pepsin	36,000	Diphtheria Anti-Toxin	90,500
Trypsin	36,000	Hexokinase	96,000
Chymotrypsin (α)	40,000	Catalase	250,000
Insulin	48,000	Urease	480,000
Hæmoglobin	63,000	Tobacco Mosaic Virus	15–20,000,000
Diptheria Toxin	74,000		

easily be followed. Protein analysis in the past has been bedevilled by the difficulty of preparing pure proteins. Now that methods of isolating pure proteins are well known and tests of their homogeneity available, there is no excuse for accurate analytical work on anything but thoroughly tested single proteins. Excellent analytical results are now being obtained; especially, in this country, by Professor Chibnall and his school at Cambridge.

Table II shows his figures for the protein "insulin"—one of the few examples for

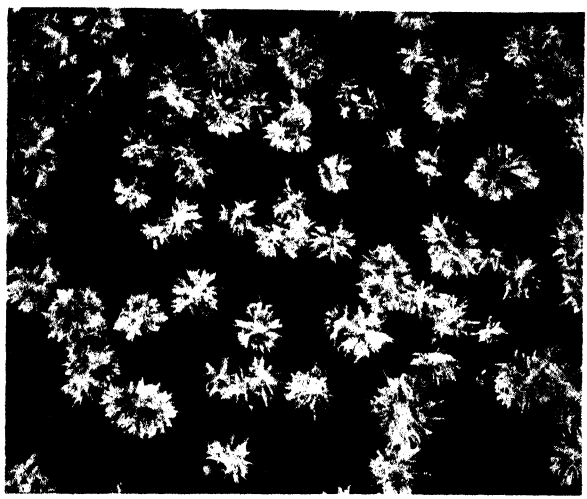


FIG. 9.—*Ribonuclease crystals (Kunitz)*

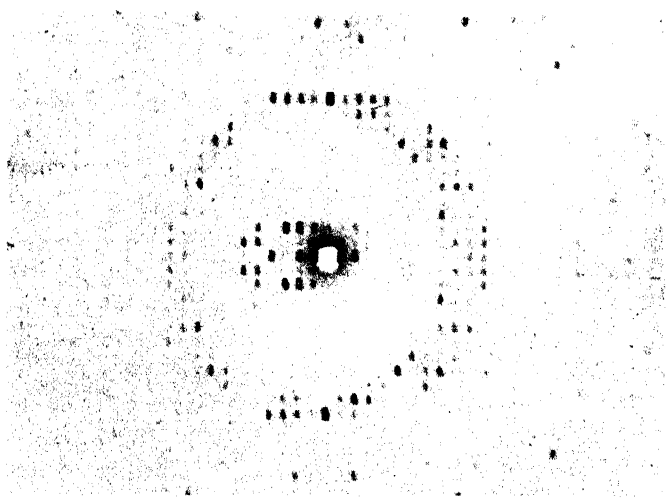


FIG. 10.—*X-ray diffraction photograph of a single crystal of human CO-hæmoglobin by Dr. M. Perutz*

TABLE II

COMPOSITION OF INSULIN

	Residues in 12000	*Residues in* 48000
Arginine	2	8
Histidine	4	16
Lysine	2	8
Glutamic Acid	15	60
Aspartic Acid	5	20
Cystine /2	12	48
Tyrosine	9	36
Alanine	6	24
Valine	8	32
Phenylalanine	6	24
Serine	6	24
Threonine	2	8
Leucines	14	56
Glycine	7	28
Proline	3	12
Total number of Residues ..	101	404

Percentage of N in molecule accounted for 96·4 per cent.

which fairly complete data are available, about 96 per cent. of the molecule being now accounted for. The smallest molecule into which all the analytical data can be fitted weighs 12,000, but the actual molecule is probably four times this size and the table shows the number of "residues" of the various amino-acids present in the molecule. Of how these are arranged in the molecule, in what order and configuration, we are largely ignorant. You may judge how far we are from reconstructing such a molecule in a test-tube!

Although we do not know how the protein molecule is built, it is a fair inference that it is a precise and orderly structure. The formation of crystals denotes orderliness and exact molecular repetition. The clear pictures which have been obtained of X-ray diffraction from protein crystals also indicate a high degree of order down to atomic dimensions. Fig. 10 shows an X-ray photograph obtained with a human carbon monoxide-hæmoglobin crystal by Perutz. Each spot is produced by diffraction from planes of atoms with a particular spacing, but the complication of the molecule makes their interpretation excessively difficult. Whatever the structure is, it is easily spoilt.

Proteins are easily "denatured" by heat and by treatment with certain chemicals. Everyone is familiar with the change which takes place in the protein of egg white in the boiling of an egg. The proteins lose much of their specificity; they can no longer be crystallised. Instead of being orderly structures they are now chains of amino-acid residues in more or less disorder. The solubility of the protein is lost because "hydrophobic" groups which have been tucked away inside are now exposed. But none of the amino-acid chains are broken in the process—only the more elusive bonds which hold the chains in their proper positions in the orderly structure of the natural protein.

Protein Nature of Enzymes

The suggestion that enzymes were proteins was not accepted without struggle. There were sceptics who said that the protein was merely the carrier of the true catalyst. But every effort to separate the protein from the enzyme failed and very strenuous efforts were made by the Northrop group. For example, pepsin is easily inactivated by heat, alkali, etc., and by ultra-violet light. Whatever the agent it has always been found that the degree of inactivation exactly parallels the destruction (denaturation) of the protein. When pepsin diffuses into water, the activity diffuses at just the same rate as the protein. After many experiments of this kind with a number of enzymes, we can be "almost certain that the enzymes *are* proteins". (I quote a statement by Northrop in a lecture to the American Chemical Society, describing ten years' work, which was perhaps unduly modest in its claim.) There are, however, cases, as we shall see later, in which an active *part* of the enzymes, a *prosthetic group*, can be separated.

You may perhaps ask if the converse is also true. Are all proteins enzymes? I suppose all, or nearly all, proteins are involved in reactions of one kind or another. Haemoglobin carries oxygen from the lungs to other parts of the body; the muscle proteins take part in exceedingly complex changes in which glucose is oxidized, heat developed and muscular work is done. Should we not call these proteins

Table III

Chronology of Enzyme Crystallization (to 1942)

Enzyme	Date	Investigator
Urease	1926	Sumner
Pepsin	1930	Northrop
Trypsin	1931	Northrop and Kunitz
Chymotrypsin	1933	Kunitz and Northrop
Yellow enzyme	1934	Theorell
Carboxy-peptidase	1935	Anson
Ficin	1936	Walti
Catalase (beef liver)	1937	Sumner and Dounce
Alcohol dehydrogenase	1937	Negelein and Wulff
Papain	1937	Balls, Lineweaver, and Thompson
Lysozyme	1937	Abraham and Robinson
Tyrosinase	1938	Dalton and Nelson
Lecithinase	1938	Slotta and Fraenkel-Conrat
Glyceric aldehyde-diphosphate dehydrogenase	1939	Warburg and Christian
Ribo-nuclease	1939	Kunitz
Ascorbic acid oxidase	1939	Tadokoro and Takasugi
Lactic dehydrogenase	1940	Straub
Catalase (beef erythrocytes)	1941	Dounce, Laskowski and Sumner
Chymo-papain	1941	Jansen and Balls
Carbonic anhydrase	1941	Scott and Mendive
Animal phosphorylase	1942	Green, Cori, and Cori

enzymes also? I think it is a question of function. It seems better to distinguish as enzymes those proteins which act as biocatalysts. They must bring about chemical changes when present in small amounts, without themselves undergoing any change, other than that caused by their inherent instability.

No doubt there will be borderline cases, but most recognised enzymes clearly fulfil this criterion. Pepsin solutions containing 10^{-7} gm. of protein nitrogen have a powerful effect on the clotting of milk; rennin crystals can clot 10^7 times their weight of milk at 37° in ten minutes, 1 milligram of urease crystals produces 100 mg. of ammonia nitrogen in five minutes when acting on urea at 20°; it is said that one molecule of catalase can decompose 2,600,000 molecules of H_2O_2 per minute at 0°. These are impressive figures, but not notably greater than those found in many cases of inorganic or organic catalysis. I shall discuss their meaning later.

A considerable number of enzymes has now been crystallised (Table III), and the list is being rapidly added to. A new world of great beauty and fantastic variety has been revealed to the chemist. We are only beginning to understand its complexity and extent. They are produced in great profusion by all living things. There must be few types of reaction which are not performed somewhere in nature with a great deal less fuss than by the rather roundabout methods the chemist often has to resort to in his laboratory. Even the simpler forms of life, fungi and bacteria, elaborate a great variety. Since these live on preformed organic matter, they pour out enzymes into the surrounding medium in order to prepare their food in a form in which they can utilise it. They have, as it were, an external stomach. In the culture medium of *Aspergillus oryzæ* (the source of the well-known taka-diastase), many types of enzymes have been detected and no doubt there are others (Table IV).

TABLE IV

TYPES OF ENZYMES IN CULTURE MEDIUM OF *Aspergillus Oryzae*

α-Amylase	Catalase	Cellulase
β-Amylase	Proteinase	Cytase
Maltase	Polypeptidase	Phytase
Lactase	Dipeptidase	Nuclease
Pentosanase	Rennin	Sulphatase
Pectinase	Lipase	Phosphatases
Trehalase	Amidase	
Tannase		

You might perhaps ask, if crystallising enzymes is so easy, what is the recipe? Unfortunately, it is impossible to give a prescription which will work in any case. It often takes a very long time to discover the proper conditions. There are some general rules. The purer an enzyme is the easier it is to crystallise. Some impurities, such as mucous material, are fatal to success. The enzyme must be undamaged. Mixture with denatured material nearly always interferes with crystallisation. Finally, the best conditions for crystallisation are a slight degree of supersaturation. Too much supersaturation usually produces amorphous material. It is also desirable to work with considerable quantities of enzyme (grams at least) and solutions in which the enzyme concentration is fairly high.

Fermentation Processes

Since a complete account of enzymes would cover nearly all the chemistry of living things and more besides, it is only possible to give in the time available a few examples of enzymic processes involved in fermentation. Although alcoholic fermentation was one of the earliest examples of enzyme action to be investigated, it has proved to be one of the most complex trains of reactions so far known. Long ago Harden and Young discovered that phosphate was involved in fermentation, a fact which they expressed in the formula:

$$2C_6H_{12}O_6+2Na_2HPO_4=2CO_2+2C_2H_5OH+2H_2O+C_6H_{10}O\,(Na_2PO_4)_2$$

(hexose diphosphate).

The full working out of the fermentation process is probably not complete, but the general outlines are known and the astonishing fact emerges that the process is paralleled step by step, except at the very end (Table V) by the reactions involved in the oxidation of glucose in muscle tissue.

Table V.A.

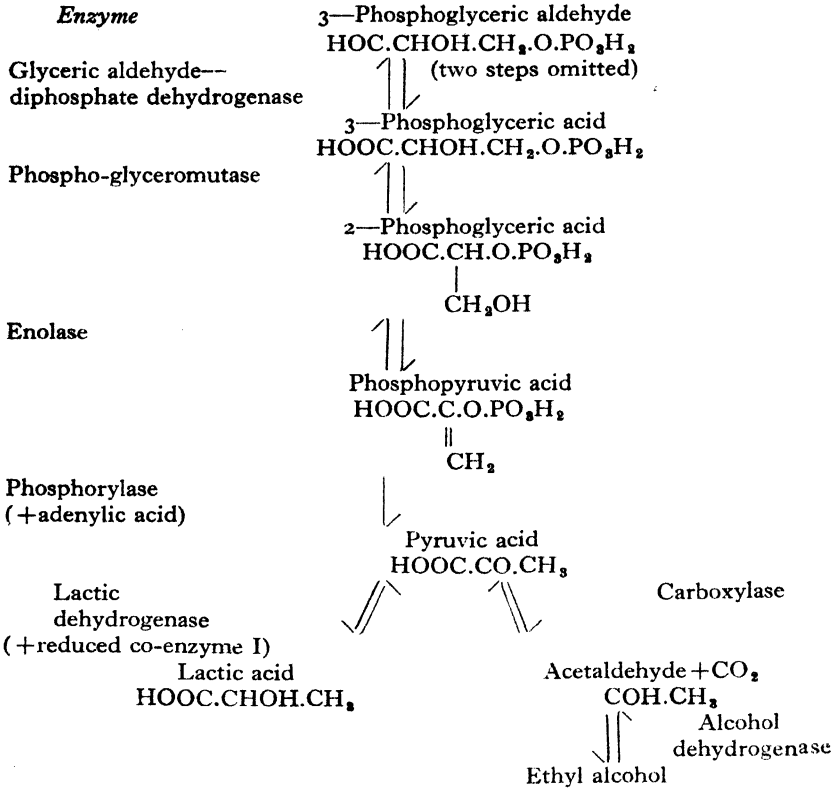
First stages of fermentation of carbohydrate and of muscle glycolysis

Enzyme		
	Starch or glycogen	
Phosphorylase	⇅	
	Glucose—1—phosphate	
	$H_2PO_3.O.CH.CHOH.CHOH.CHOH.CH.CH_2OH$	
	$\llcorner\_\_\_\_\_O\_\_\_\_\_\lrcorner$	
Phospho-glucomutase	⇅	
	Glucose—6—phosphate	Hexokinase ← Glucose + A.T.P.*
	$HO.CH.CHOH.CHOH.CHOH.CH.CH_2.O.PO_3H_2$	
	$\llcorner\_\_\_\_\_O\_\_\_\_\_\lrcorner$	
Phospho-hexo-isomerase	⇅	
	Fructose—6—phosphate	
	$HO.CH_2.COH.CHOH.CHOH.CH.CH_2.O.PO_3H_2$	
	$\llcorner\_\_\_\_\_O\_\_\_\_\_\lrcorner$	
Phosphatase ($Mg.^{++}$)	⇅	
	Fructose—1, 6—diphosphate	
	$H_2PO_3.O.CH_2.COH.CHOH.CHOH.CH.CH_2.O.PO_3H_2$	
	$\llcorner\_\_\_\_\_O\_\_\_\_\_\lrcorner$	
Aldolase (Zymohexase)	⇅	
	3—phosphoglyceric aldehyde $CHO.CHOH.CH_2.O.PO_3H_2$ ⇌ dihydroxyacetone phosphate $CH_2OH.CO.CH_2.O.PO_3H_2$	

*A.T.P.=adenosine triphosphate

TABLE V.B.

FINAL STEPS OF CARBOHYDRATE FERMENTATION AND OF MUSCLE GLYCOLYSIS



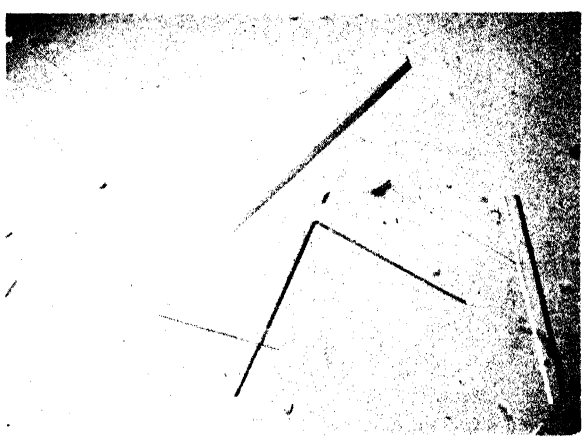


FIG. 11.—*Hexokinase crystals (Kunitz)*

The first essential step is the introduction of a phosphate group into the glucose by a phosphate carrier (adenosine triphosphate), through the agency of an enzyme, hexokinase (Fig. 11), which has recently been purified and isolated from yeast by

Cori and by Kunitz. It may be of interest to note that this work was done as a war project, because it was suggested that hexokinase is peculiarly sensitive to the action of mustard gas and the characteristic blisters produced by small exposures to mustard are probably due to the hexokinase process being put out of action.

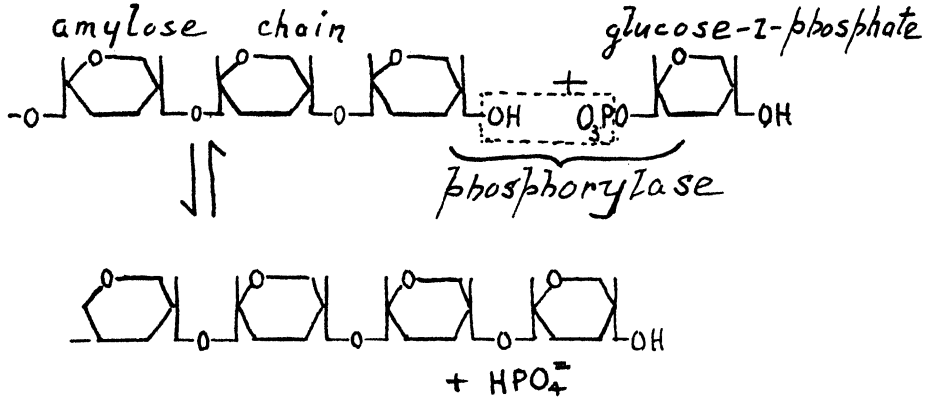


FIG. 12.—*How long chains of amylose (starch) are built up by the enzyme phosphorylase*

From glucose–6–phosphate there are two paths, one upwards leading to starch in plants and to glycogen in animals. The enzyme synthesis of starch was first achieved by Hanes using a phosphorylase from potato juice. This enzyme adds glucose units to an existing chain, thus building up long chains of simple glucosidic units which constitute a simple form of starch (Fig. 12).

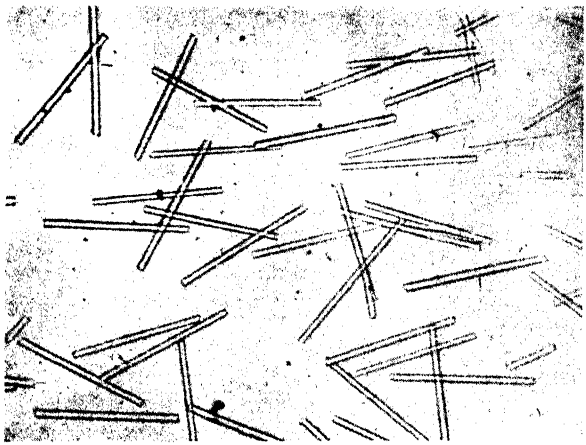


FIG. 13.—*Crystalline muscle phosphorylase (Cori and Green)*

Natural starch is a mixture containing both straight and branched chains and there are other enzymes responsible for the branching, as Bourne and Peat have shown.

A similar enzyme in the animal organism, muscle phosphorylase, has been isolated and crystallised by Green and the Cori's (Fig. 13). It is present in an aqueous extract of rabbit muscle to the extent of no less than 2 per cent. of all the protein

extracted. It needs a little glycogen to start it acting, but when that is provided it will build up (*in vitro*) a glycogen-like compound. The natural glycogen consists of branched chains, as in Fig. 14, where each little loop represents the glucosidic unit, the whole molecule having a molecular weight of from 1 to 2 million. The artificial material is somewhat simpler and its nature depends on the kind of glycogen provided to start the reaction. Both of these reactions are reversible, synthesis or breakdown of the starch occurring according to the circumstances.

Returning now to the scheme of fermentation, we see going downwards a long series of reactions, leading to pyruvic acid, which is turned into lactic acid in muscle and to acetaldehyde and alcohol by yeast. Several of the enzymes involved have been crystallised, *e.g.*, zymohexase from muscle which breaks down diphosphorylated glucose into two three-carbon atom compounds, a dehydrogenase and carboxylase from yeast. I draw attention to these latter as I shall speak of their constitution later.

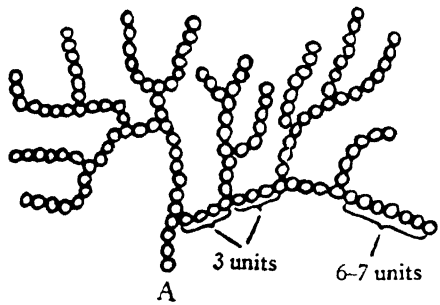


FIG. 14.—*Natural glycogen (animal starch)*

USES OF ENZYMES

It is impossible in a short time to give any useful account of the many enzyme processes employed in industry, but I might perhaps make some remarks of a general nature. The tendency in the past in the fermentation industries has been to use organisms selected to bring about mainly a desired change. With the isolation of enzymes, which are often sufficiently stable to be kept for long periods in the dry state without deterioration, I think much more use may be made of specific enzymes. They may be used to make a process more easily balanced in a desired direction than when performed with the natural product. It is being realised that in the traditional enzyme process, the usual enzymes are not the only ones or necessarily the best. In malt, as is well known, there are two principle amylases, distinguished as α and β, which attack the starch molecule in different ways, the α-amylase producing mainly dextrins and the β-amylase mainly maltose. Starch itself is a complex material consisting of both straight chains (amylose) and branched chains (amylopectin) of glucosidic rings. β-amylase converts amylose completely to maltose, but is unable to act on the amylopectin to a greater extent than about 50 per cent., the residue being a dextrin, which is not attacked by the β-amylase. It is supposed that the β-amylase removes maltose units from the chain until a branching point (α-linkage) is encountered. It has been shown by Haworth and his co-workers, that this resistance can be removed by contact with α-amylase, when the β-amylase can act further. Fig. 15 shows this sequence of changes, as

envisaged by Haworth and his co-workers. It must, however, be pointed out that the changes brought about by the α-amylase are not well understood. It is possible that some reorganisation occurs under the influence of phosphorylases present as impurities. These uncertainties can only be resolved by the preparation of pure single enzymes.

There are also other sources of amylases—moulds such as the well-known *Aspergillus oryzæ*, which yields takadiastase, a mixture which has numerous uses. Bacterial amylases have also been prepared, *e.g.*, from *B.-macerans*, and used to utilise plant waste. Wheat flour contains amylases, which produce the maltose required by the fermenting yeast. It has been shown that by the addition of β-amylase a spongier dough is obtained and the objectionable dextrins are avoided to some extent.

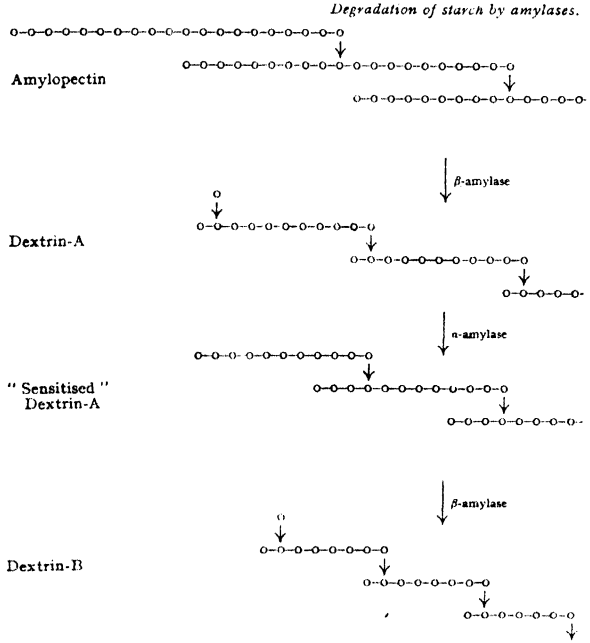


FIG. 15.—*Action of amylases on starch (Haworth)*

The same applies to proteolytic enzymes which have many uses—for clarifying beer and cider, "tenderising" meat, dehairing of skins, and uses in medicine and cosmetics. Besides the usual animal sources they can be obtained from plants. Papain has long been used to obtain an increased liberation of amylases from malt; ficin, a powerful enzyme from unripe figs, has anthelmintic properties and is said to digest parasitic worms in vivo without harming the intestine. On the other hand, the proteolytic enzymes of wheat flour produce undesirable changes. They act on the gluten and give rise to a lumpy dough and various oxidizing agents are added to most flours with the object of inactivating them.

There are also great possibilities in the synthesis of difficult compounds. The synthesis of cane sugar by a chemical process has proved to be extremely difficult because both glucose and fructose from which it is formed occur in two isomeric

forms and natural sucrose is only one of four possible combinations of them. A bacterial sucrose phosphorylase has been obtained by Hassid, Doudoroff and Barker which catalyses the reversible reaction:

Glucose–1–phosphate + fructose = sucrose + inorganic phosphate

and by means of it sucrose was obtained in appreciable quantities. There seems every reason to expect that difficult compounds like penicillin might also be made enzymically. The fungus, *Penicillium notatum* makes it, almost certainly, by means of enzymes. If we knew the intermediates we might also isolate the enzyme and so prepare it *in vitro*. It is possible, of course, that this procedure might be more troublesome than the ordinary biological process; but it is also possible that the yield might be much greater. In the fermentation industries enzymes might also be used to change a primary economical fermentation product into related compounds, which the organism does not make economically. This possible mode of conducting chemical industry is largely unexplored, but I suggest that it would repay study, especially in countries where large quantities of waste plant products are available as raw material.

Another use of enzymes is in analysis. Enzymes are often extremely specific, so that an enzyme reaction can be used to determine the amount of its specific substrate in a mixture. Urease, as is well known, liberates ammonia from urea, its only known substrate, so that we can determine the amount of urea from the ammonia liberated. Several bacterial decarboxylases have been prepared by Gale at Cambridge, which liberate carbon dioxide specifically from particular amino-acids, and provide a most useful method of estimating them. Finally enzymes are being used more and more in the study of complex natural products, such as starches, nucleic acids, the proteins themselves, because they act specifically and more gently than the cruder and more violent agents which have in the past been the principal weapons in the chemist's armoury.

Lecture II.

THEIR MODE OF ACTION AND STRUCTURE

In my first lecture I gave a very inadequate account of different types of enzymes and of the reactions they bring about. They are, so far as is known, all proteins, *i.e.*, large soluble molecules, constructed mainly of amino-acids. They occur in the cellular and extra-cellular fluids of living organisms and have very specialised functions as biocatalysts. That is, they catalyse chemical reactions very efficiently, including numerous reactions which are quite troublesome to effect in the laboratory. How do they do this?

Speed of Enzyme Reactions

I suppose a complete answer would involve first of all a knowledge of their chemical constitutions, which, unhappily, is still remote. There are, however, some characteristics of enzyme reactions which throw light on their mode of action. It has been suggested that the speed of enzyme reactions is of a different order of magnitude to that of the ordinary reactions of the chemical laboratory and very special hypotheses have been put forward to explain it. It is a fact, however that some laboratory reactions do occur with a very great speed when conditions are

suitable—*e.g.*, neutralisation of acids by bases, and combustion, so that there does not seem to be any need to invoke an entirely different mechanism. The great possible speed of chemical reactions in fact arises from the high collision frequency between molecules. It is possible to calculate from simple kinetic theory the frequency with which molecules of any two kinds collide in a solution. It is only necessary to know their sizes, weights and concentrations. In a trypsin solution containing 0·01 mg. trypsin per cubic centimetre (1-1000th of 1 per cent.) *each* substrate molecule will have about five million collisions with a trypsin molecule each second. This may seem a large number, but you must remember that in this weak trypsin solution there are still 4×10^{14} molecules of trypsin in every cubic centimetre. It used to be thought that enzyme catalysis was analogous to the well-known cases of surface catalysis. For example, platinum black when finely dispersed decomposes hydrogen peroxide and so does the enzyme, catalase. Actually surface catalysis is considerably less efficient than enzyme action. We should have to provide about 1 square centimetre of stationary surface in order to obtain as many collisions with the substrate, as with a single enzyme molecule. Therefore very large surfaces would have to be provided. This difference is mainly because the enzyme molecules are mobile and dispersed through the liquid. At any rate it is evident that the provision of discrete catalytic *molecules* rather than surfaces is the most economical and efficient solution of the problem of bringing about reactions and the only way in which it could be improved is by the use of smaller molecules. Evidently Nature has not found molecules with weight less than 15,000 or more in most examples, which satisfy all the requirements. When Nature has failed it is unlikely that man will do any better!

If the substrate molecule were broken up every time it hit a trypsin molecule, it would not last for a fraction of a second. In ordinary chemical kinetics it has been found that all collisions are not fruitful. Generally in the reactions between simple molecules only a very small fraction of all the collisions result in reaction. This is because only those collisions which have more than a certain minimum of energy bring about reaction. For example, in the combination of ethyl bromide with diethyl sulphide, the number of collisions per cubic centimetre per second was calculated to be $1 \cdot 6 \times 10^{32}$, while the number of molecules combining per second was $1 \cdot 5 \times 10^{16}$, so that only the fraction 10^{-16} of all the collisions resulted in combination. This is because only those collisions in which the energy of the reacting molecules is about 25,000 calories (a large value) above the average, result in combination.

This extra energy required to bring about a reaction is called the activation energy. What it is can be pictured in the following way. The molecules concerned in a reaction are comparatively stable structures. That is, they exist in a state of relative equilibrium. Under the influence of the catalyst (enzyme) they pass into another state of still greater equilibrium, a process which involves the breakage of chemical bonds in the first state and their reconstitution in another way in the second. We can picture the change as the passage of the molecules from one valley to an adjacent one, over the intervening hill (Fig. 16). The height of the hill measures the "activation energy" required for the change.

The rate of reaction increases very rapidly as the activation energy is decreased.

By far the commonest function of a catalyst is to decrease the activation energy and, enzymes are no exception. It is found by careful study that the "steric" factors,

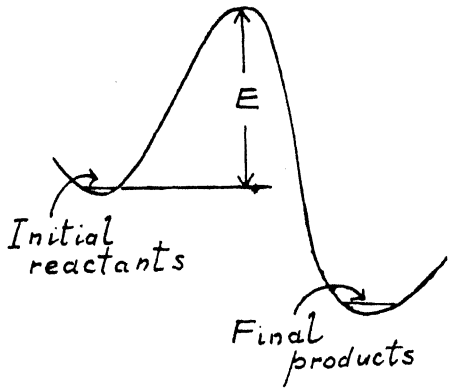


FIG. 16.—*The activation energy of a chemical reaction*

that is the non-energetic factors involved in enzyme reactions, are of the same order of magnitude as in non-enzyme reactions; but the activation energies are less

TABLE VI

ACTIVATION ENERGIES OF ENZYMIC AND NON-ENZYMIC REACTIONS

Reaction	Catalyst	Activation Energy (Cals.)
Hydrolysis of Peptide Bond ..	H^+	21,000
,, ,, ,, ..	Chymotrypsin ..	10—11,000
Inversion of Cane Sugar ..	H^+	25,700
	Invertase	11,000
Hydrolysis of Urea	Urease (reduced) ..	8,700
Decomposition of H_2O_2.. ..	Potassium Iodide ..	13,000
	Catalase	1,000

(see Table VI). The enzyme helps to bring about the reaction by helping the molecule over the energy-hill. To do this it has to combine with the two halves of

the substrate molecule in such a way as to weaken the bond between them, as in Fig. 17. This probably occurs because its combination with the molecule brings about a radical change in the electron distribution. It cannot do this, of course, unless it makes a very good fit with the substrate. As has often been said, the enzyme and its substrate must fit like lock and key. This is shown particularly well by the use of what are called stereo-isomers—*i.e.*, compounds, which have just the same structure, except that the one is the mirror-image of the other. An enzyme will act on the one but not on the other; it will act on the one it fits.

It follows that enzymes, to be effective, must be very specific. There are enzymes which act on a series of related compounds, all of which have the same general

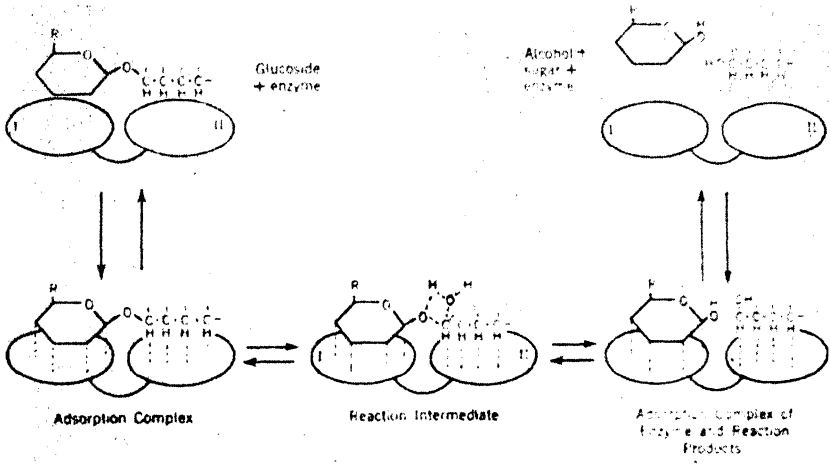


FIG. 17.—*How an enzyme acts. The example shown is a glucosidase, which splits glucosides into glucose and the alcohol (Pigman)*

pattern. These enzymes have different efficiencies with different compounds, depending on the closeness of the "fit". But sometimes, as with urease, there is only one known substrate.

So the problem which nature has solved is to produce molecules, which have a particular structure—which at least must be very closely adapted to their substrates. What are these structures? What patterns in the enzymes give them their properties?

CO-ENZYMES

With some enzymes the working parts of the molecule—or "prosthetic groups" as they are called—have been identified, because they can be separated from the protein proper. The story begins with the observation of Harden and Young in 1906 that yeast juice could be separated into two substances—which they called enzyme and co-enzyme—neither of which separately cause fermentation, but when re-mixed together can do so. The auxiliary substance (called co-enzyme I) which is

not protein in nature was shown by von Euler, Albers and Schlenk in 1935 to be composed of nicotinic acid amide, *d*-ribose, phosphoric acid and adenine (Fig. 18).

A second enzyme (co-enzyme II) which is required by a dehydrogenase was discovered in horse erythrocytes by Warburg in 1932. It is similarly constituted, containing three instead of two phosphoric acid molecules. These substances are the

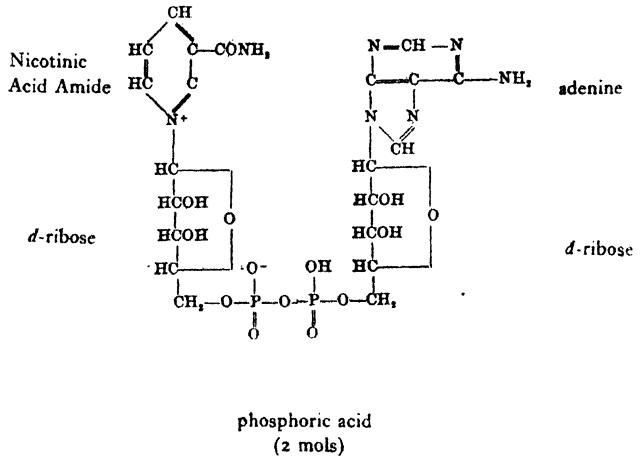


FIG. 18.—*Structural formula of co-enzyme I*

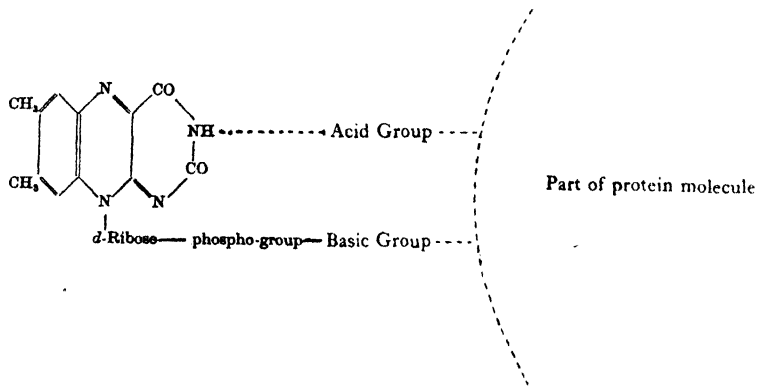


FIG. 19.—*The riboflavin phosphate molecule, showing how it combines with the protein part of the enzyme*

active groups of many enzyme systems, which bring about reductions (dehydrogenases).

Other auxiliary substances have also been found. Warburg and Christian isolated a yellow oxidation enzyme from brewer's yeast and were able to split off a co-enzyme, which has been identified as riboflavin phosphate (Fig. 19). Without this substance the enzyme does not work. When it is added the activity returns.

ENZYMES AND VITAMINS

Table VII shows some of the enzymes with their co-enzymes, which have been identified. Several of these co-enzymes have been identified with vitamins, or found to contain vitamins as important constituents. Three years after Warburg had shown that nicotinamide was an essential constituent of co-enzyme II, Elvehjem and his colleagues discovered it to be the anti-pellagra vitamin.

TABLE VII

ENZYMES AND THEIR CO-ENZYMES

Enzyme	Co-Enzyme	Function	Source
Old Yellow Enzyme (Warburg)	Riboflavine phosphate =(Iso-alloxazine mono-nucleotide)	Oxidizes the reduced form of co-enzyme II	Brewer's yeast
d-amino acid .. oxidase	Iso-alloxazine-adenine-dinucleotide*	Oxidizes d-amino acids	Animal organs
Cytochrome-C-reductase	Iso-alloxazine mono-nucleotide (Riboflavine phosphate)	Catalyses reduction of cytochrome-C by Co-enzyme 2	Yeast
Carboxylase (Green)	Mg. and thiamin pyro-phosphate	Removes CO_2 from terminal —COOH groups: $CH_3CO.COOH \rightarrow CH_3COH + CO_2$	Yeast (bacteria)
Decarboxylases of lysine, ornithine, arginine and tyrosine	Phosphoric ester of pyridoxal	Removes CO_2 from tyrosine, etc.	Bacteria

*This is similar to co-enzyme I, with an iso-alloxazine group in place of the nicotinic acid amide.

Vitamin B_2 was identified by Kuhn and Karrer with riboflavin. The order of discovery was reversed with thiamin. It was identified as Vitamin B_1 by Williams and Cleve in 1936 and one year later shown to be the prosthetic group of yeast carboxylase. Vitamin B_6 was identified with pyridoxine in 1938, and in 1944 Snell discovered a more active form of the vitamin, pyridoxal, and showed that the phosphoric ester of pyridoxal was the co-enzyme of tyrosine decarboxylase. It has since been found to be the co-enzyme of other amino-acid decarboxylases.

Pyridoxal and pyridoxamine have also been recognised as the co-enzymes of a

transaminase—an enzyme which has been found in heart muscle and which transfers amino-groups from glutamic to aspartic acids, in the reaction:

oxaloacetic acid + *l*-glutamic acid = ketoglutaric acid + *l*-aspartic acid.

This seems to be an important reaction in both plants and animals, but the reason for it in the whole complex of reactions is not clear.

Perhaps for the benefit of chemists, I might give the sequence of reactions which brings about this change (Fig. 20), because in this case the method of enzyme action is better established than in any other; but the way in which the protein determines the specificity is still its own secret. Perhaps in time all the vitamins, such as biotin, pantothenic acid, folic acid, vitamins A, K and D, etc., will be recognised as prosthetic groups of enzymes. At any rate the vital need of organisms, which cannot synthesise them themselves, for these substances and the small amounts of them which satisfy that need, is easily understood. Table VIII by Dr. B. C. J. G. Knight sums up the position admirably.

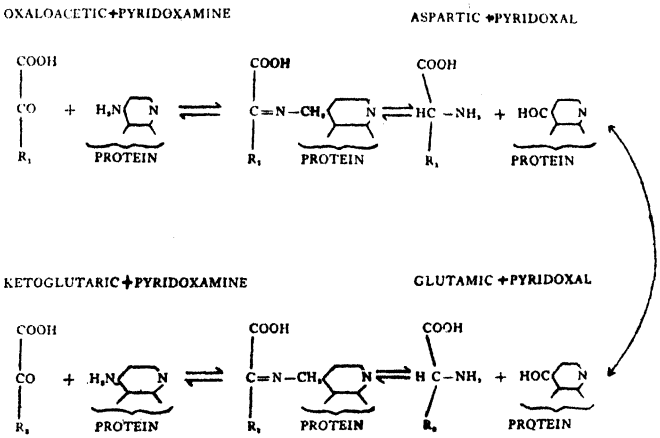


FIG. 20.—*Mechanism of Transamination Reaction : Oxaloacetic acid + l-glutamic acid ketoglutaric acid + l-aspartic acid (Schlenk and Fisher)*

BACTERIAL INHIBITORS

It appears, then, that the vitamins are essential to organisms which cannot make their own, because they are essential constituents of enzyme systems which function in small amounts. Anything which interferes with the action of these vitamins will obviously also prevent the proper functioning of the organism. Now the discovery of the sulphonamides opened up a class of substances which can inhibit bacterial growth. The reason for this inhibition was very obscure for a time; but a clue was found in the observation of Woods (1940) that *p*-amino-benzoic acid was antagonistic to this inhibitory action. The presence of a little amino-benzoic acid prevents inhibition by sulphonamides. Now amino-benzoic acid is essential to the growth of many organisms. It is a constituent of folic acid, and perhaps has other uses, since it has been isolated from yeast in the form of a polypeptide, containing one molecule of it to ten glutamyl residues. At any rate it is an essential growth substance of many organisms.

TABLE VIII

GROWTH FACTORS FOR MICRO-ORGANISMS: THEIR RELATION TO THE NUTRITION OF OTHER ORGANISMS, AND THEIR FUNCTION IN ENZYME SYSTEMS

Substance	Species for which the substance was first recognised as an essential nutrient	Species in whose nutrition it was subsequently found to be implicated	Enzymes or substances of which it is a component
Aneurin (vitamin B_1)	Higher animals	Bacteria, lower fungi, protozoa, roots of higher plants	Co-carboxylase, aneurin-protein enzymes
Riboflavin (vitamin B_2)	Higher animals	Bacteria, insects, lower fungi	Several flavoprotein enzymes
Pyridoxin (vitamin B_6)	Higher animals	Bacteria, insects, lower fungi, plant roots	Co-enzymes of tyrosine decarboxylase
Pyridine nucleotides	*Haemophilus influenzae*	—	—
Nicotinic acid	*Staph. aureus*	Higher animals, insects, plant roots	Co-enzymes I and II, pyridine-protein enzymes
Biotin	Yeasts	Bacteria, higher animals, insects, lower fungi	—
Pimelic acid	*C. diphtheriae*	—	Role in biotin biosynthesis
Pantothenic acid	Yeasts	Bacteria, higher animals, insects	—
β-Alanine	Yeasts	*C. diphtheriae*	Pantothenic acid
p-Aminobenzoic acid	Bacteria	Higher animals, lower fungi	Folic acid
Inositol	Yeasts	Mice, insects, mould (*Ashbya gossypi*)	—
Uracil	*Staph. aureus* (anaerobic)	—	—
Glutamine	Streptococci	—	—

Sulphanilamide, the simplest of these compounds, is a very close chemical analogue of *p*-amino-benzoic acid, having the sulphonamide group—SO_2NH_2 instead of the ordinary acidic group—COOH (Fig. 21). Wood's theory was that the sulphanilamide "impersonates" the necessary aminobenzoic acid. It combines with the proteins or enzymes and co-enzymes of which the latter is the necessary constituent, but the enzyme containing the "false" constituent is unable to carry out its functions properly; it is "warped" and no longer makes a good fit with its substrate.

Acting on this theory we should be able to find molecules which inhibit the action of other enzymes. They should be, we should expect, chemical analogues of vitamins, or other essential constituents of enzymes. They must be close enough to the essential substance to be incorporated in the structure of the enzyme. The

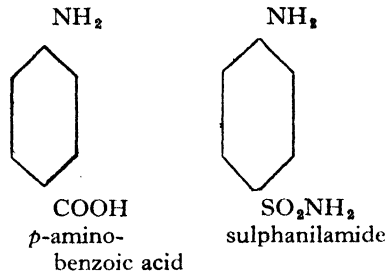


FIG. 21 —*p-amino-benzoic acid, a substance essential to the growth of some micro-organisms and sulphanilamide, an inhibitor*

enzyme builder must be deceived. But they must be sufficiently different to spoil the functioning of the enzyme molecule which is so formed. Fig. 22 shows some of the recognised inhibitors of some of the vitamins.

This concept has given a new direction to chemotherapy. In order to combat an invading organism, it is necessary to find its Achilles' heel—an enzyme system which is more vulnerable than that of its host, and can be inhibited by a suitable compound. While this has given a rational mode of investigation which has been very welcome in chemotherapy, it is only fair to say that so far nothing more effective than the original class of sulphonamides has been discovered.

But this is, probably, in any case an over-simplified picture and the relation between bacterial inhibitors and their antagonists is not nearly so simple as represented. It also has definite limitations; all vital actions are not enzymic and all enzymes do not have separable co-enzymes, nor distinguishable prosthetic groups.

ENZYMES WITHOUT SEPARABLE PROSTHETIC GROUPS

Pepsin, trypsin, etc., consist entirely, so far as is known, of amino-acid residues. Their properties must be the result of a molecular pattern, about which we know practically nothing. Until methods of unravelling the structure of the protein molecule are available—they are known in principle, the difficulty is the practical one of dealing with the great complication—we have little hope of discovering what structures are at work. Something can be done by acting on the intact protein with

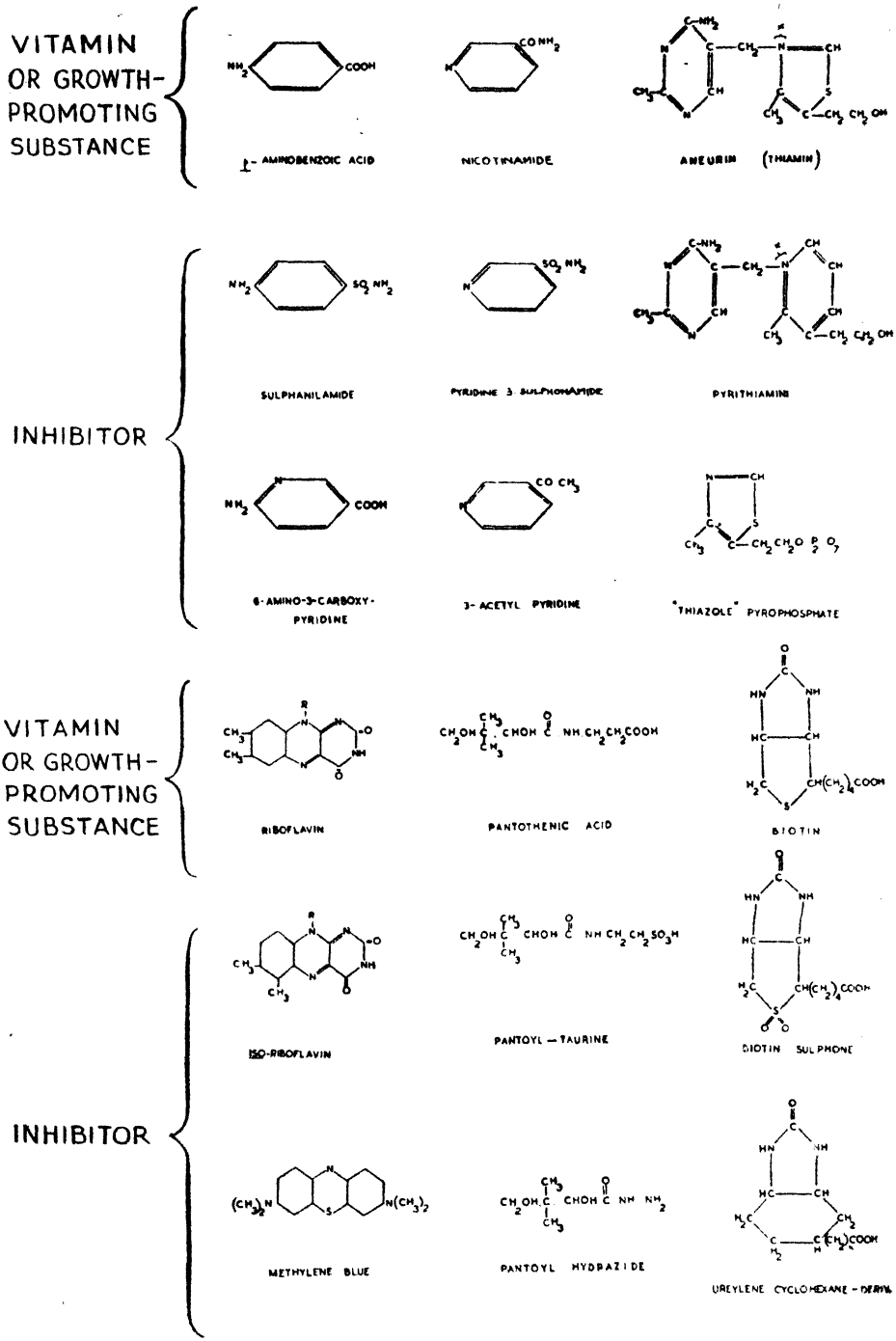


FIG. 22.—*Some of the vitamins and their inhibitors (After Knight)*

reagents which combine with particular groups of the various side chains; for example, various groups can be acetylated by ketene. When this was done with pepsin it was found by Herriott that acetyl-pepsins are obtained which retain a part of the activity. The groups first acetylated are those of lysine, so it appears that these are not essential to the activity. But iodination of the tyrosine with iodine destroys the activity rather more rapidly, and it is concluded that the tyrosine residues are particularly involved. This approach is obviously of limited application and we have not much hope of discovering the effective molecular patterns until the structure is much more worked out. We do not know whether there is one active centre to the enzyme molecule or more than one and, so far as I know, no one has any idea what kind of a structure it is in a protein which causes the severance of peptide bonds in another molecule.

At this point I should perhaps mention the recent surprising observations of Rothen, who claims to have demonstrated trypsin action, through a film of plastic material 65Å or more thick, *i.e.*, several times the diameter of the trypsin molecule. The evidence is a little indirect and it may be best to keep an open mind at present, but if this were substantiated it will do much more than change our ideas of enzyme action—it will bring about a radical revision of ideas of the forces acting between molecule and molecule. It is true that long-range forces between large molecules have been suspected, the nature of which are not very clear, but it is hard to understand how they could be so specific. Whatever the outcome, it will still be important, perhaps even more important, to try to discover what molecular properties are responsible.

Enzymes and Trace Elements

Vitamins are not the only materials required for the elaboration of enzyme systems. A number of enzymes have been isolated which contain metals as essential constituents. Several enzymes containing copper have been distinguished; for example, tyrosinase, an enzyme which oxidises phenols and is widely distributed in plants and animals, contains 0·3 per cent. of copper, and ascorbic acid oxidase present in squash, bananas, cucumbers, etc., contains from 0·15 to 0·25 per cent. of copper. Carbonic acid anhydrase, which accelerates the release of carbon dioxide from the blood, contains 0·3 per cent. of zinc; carboxylase requires magnesium in its co-enzyme. There are also a number of enzymes, catalase, peroxidase and cytochromes which contain iron. There are probably enzyme systems containing other metals, and the fact that organisms require the so-called "trace" elements in very small quantities is explicable on the assumption that they enter into vital enzyme systems. The five elements, iron, manganese, boron, copper and zinc, at least, appear to be essential to plant growth at concentration of less than one part in a million and their absence produces various diseases, although much larger amounts may be toxic. The application of manganese and zinc to marshland fields in Kent increased the yield of potatoes from seven to eleven tons per acre. In south-east Australia, where copper deficiency exists, 14 lb. of copper sulphate per acre doubles the yield of oats. Plants can often grow quite well without copper up to blossoming time, but seed formation is interfered with.

It is quite likely that other elements are involved in traces in plant life, although

so widely distributed that deficiency effects have not been noticed. Even when the soil provides a sufficiency for the needs of plants, deficiencies in the requirements of animals feeding on the plants may occur. Diseases due to cobalt deficiencies in sheep and cattle are now well known in various regions. For example, in Scotland, sheep "pining" occurs on soils with less than five parts per million of cobalt. It has been found that this condition can be corrected by cobalt (together with copper) taken orally, but not when injected directly into the blood. It has been suggested that this is due to the cobalt being required for the nutrition of the micro-flora in the rumen of the animal, which manufacture vitamin B—a suggestion supported by the fact that when radio-active cobalt is fed to the animal, it does not appear in the blood. If this is true, the emaciation and eventual death of the animal is due to the lack of a milligram or so of cobalt daily, which is apparently required in the enzyme systems of certain bacteria, which synthesise "B" vitamins (or perhaps some other substances) which the animal itself needs in small amounts. The whole situation rather reminds one of the disastrous consequences of the loss of a nail in the nursery tag—but in this case the nail is a cobalt one, and it possibly holds an enzyme together.

Lecture III.

THEIR FORMATION AND PLACE IN NATURE

I do not think I need to emphasise any further the profusion of enzyme reactions. I might, however, give two further illustrations, the first of the distribution of an enzyme throughout an organism; the second of the number of enzymes. It has been found possible to make the location of enzymes within the cells visible, by a staining process similar to that used in making tissue sections. A substrate is used, of which the decomposition products can be "fixed" in the position they are produced in and so made visible. In this way the enzyme produces an "autograph" showing its distribution. Fig. 23 shows pictures obtained in this way of the phosphatase of the developing wheat root.

As regards number, we may consider bacteria, which are prolific sources of them. Owing to their small size, they have to carry out their functions with great economy of material. I might mention some interesting figures given in a recent article by McIlwain, who recently pointed out that in a bacterium of dried weight 10^{-18} gm., of which one-third is protein, there will be 200,000 protein molecules in all, of molecular weight 100,000, which is the order of magnitude most commonly found in enzymes. Some of this material may be structural, and some undoubtedly constitutes the reproductive elements, the genes, of which I shall speak later. We can thus estimate the total number of enzyme molecules as not more than 100,000 and probably less. McIlwain estimated the number of *known* reactions which bacteria must bring about, in carbohydrate metabolism, the synthesis of amino acids, peptides, lipids, nucleic acids and vitamin-like compounds, as about 300. It would be rash to assume that all possible reactions are known. The actual number is probably considerably greater, say 1,000 or 2,000; which gives an average number

of molecules of any one enzyme per cell as not more than 50 to 100. McIlwain has suggested that in many cases a few enzyme molecules per cell are sufficient to bring about the reactions at the required rate. These numbers are, of course, concentrated in a very small volume. 100 molecules to 10^{-12} cubic centimetres is equivalent to 10^{14} molecules per cubic centimetre, say 0·01 milligram of enzyme per cubic centimetre, which is the kind of concentration often employed in enzyme studies in the test-tube. A comparatively small number of molecules of each kind of enzyme is thus sufficient to give a reasonable rate of enzyme action in the cell. The same is, of course, true of the co-enzymes, which, as McIlwain has shown, are also present in quantities of the same order (100–10,000 molecules per cell). Some economy of



(*a*) (*b*)

FIG. 23.—*Enzyme Autographs (Glick)*

(*a*) *The longtitudinal section of a tip of a wheat root showing a phosphatase reaction most pronounced at the root cap and at the region behind the tip*

(*b*) *A section of wheat epicotyl showing a reaction for phosphatase, relatively diffuse in the inner leaves*

requirements may be afforded by having the same co-enzyme to function with several enzymes—this may be the reason why the co-enzymes are separable from the protein moiety—it enables them to pass from enzyme to enzyme molecule.

CONTROLLING FACTORS

How are all these enzyme actions organised? Is the cell just a sack containing the enzymes and are their substrates all mixed up, or are there any controlling and marshalling factors? We can say that the amount of thermal agitation in a volume of this magnitude is quite considerable. According to ordinary kinetic theory the collisions between any one enzyme and its substrates will be numerous enough at these concentrations to give a reasonable rate of action without any special mechanism for bringing enzyme and substrate together.

The situation is different in complex multi-cellular organisms, where different cells have specialised functions. One cell may have to produce a particular enzyme

or a few enzymes in considerable quantity and it will be necessary for the functioning of the organism that it should do this at the right time and in a way which is co-ordinated with the activities of other cells. There must be mechanisms controlling the production, liberation and activity of enzymes.

We have only a limited knowledge of such factors. For example, Northrop and Kunitz extracted from the pancreas a substance which has a powerful inhibitory action on trypsin, which was found to be a polypeptide (a fragment of a protein). Other inhibitors have been found. Trypsin inhibitors occur in widely different materials, such as blood and soya bean. Their exact function is not very clear. In the pancreas it may be to prevent too rapid an activation of these enzymes (which are activated by a proteolytic process), until they are wanted. But what they do in other cases is not obvious. It may be significant that the new antibiotics gramicidin and tyrothricin are polypeptide in nature and possible that their action in inhibiting bacterial growth is due to some such action. Gramicidin blocks phosphate uptake in cells and so interferes with the synthesis of polysaccharide storage products. However, it has been shown that penicillin does not affect the glucose metabolism and its action seems to be concerned with nucleic acid and growth rather than with the enzymes of metabolism.

In higher organisms the substances most concerned in the chemical control of bodily activities are the *hormones*—internal secretions, which have a profound effect on many metabolic changes, on growth and sexual functions, etc. For example, insulin controls in some way the sugar metabolism in muscle. Without insulin, glucose cannot be utilised by animals and it has long been a puzzle to find at what point insulin exerts its action. Until recently, no clue to this had been found, but the Cori's have recently observed that while hexokinase action is inhibited by the extract of the anterior pituitary gland, this inhibition is abolished by insulin. The proper functioning of the glucose metabolism thus depends on a delicate balance between the insulin secretion of the pancreas and that of the anterior pituitary gland.

This pregnant observation is only the beginning of the discovery of the nature of hormone action and we may expect to learn much more about how they regulate enzyme processes in the future.

Origin of Enzymes

In my remaining time I should like to discuss briefly the question of how enzymes are elaborated. As we have seen, every organism requires very great variety of highly differentiated and elaborate protein molecules. In the first place, one may perhaps note that there are few signs of any improvement of enzymes in the ascent of the evolutionary series. The enzymes of the lowest organisms we know seem to be very much like the enzymes of the highest. Bacteria produce amylases, lipases, proteolytic enzymes, etc., which, although specific, seem to be very much like those of man. Indeed, one of the most significant of all the facts which have emerged is the great uniformity of the chemical bases of all types of life which have survived until the present day. The elaboration of the higher forms of life has involved an increasing specialisation of cell function, but the enzymes themselves seem to have gone on through countless generations without any apparent improvement, and one must also say, on the whole, without any *new* kinds appearing. It is

very likely that the higher organisms use a few novel types of enzymes not present in unicellular ones, *e.g.*, in nervous action, but the enzymes concerned, such as acetylcholinesterase, which functions at nerve endings, may not be more than a modification of the less specialised form of esterases.

When we come to the method of synthesis of enzymes, there are two questions to be considered:

(1) The method by which enzyme molecules are elaborated in the growth of a single organism.

(2) How this machinery is passed on from one cell generation to the next.

That is, whatever the machinery of formation of enzymes is, it must be capable of being reduplicated.

In the first place, I must point out that the formation of a protein molecule in the test-tube has never been observed. So far as we know, there are no "protein synthesising" enzymes. Protein molecules, in fact, could not be formed *spontaneously* to any great extent by the coming together of amino-acid molecules, since the formation of the peptide bond involves an increase of free energy. It is true that in one or two cases the synthesis of rather special peptide bonds under the influence of enzymes has been reported (Bergmann, Cohen and McGilvery) but, in general, it is likely that the amount of a *dipeptide* in equilibrium with the two amino-acids concerned is quite small and the proportion decreases very rapidly with the complexity of the peptide, so that the chance of forming a protein by the spontaneous condensation of the proper amino-acid molecules is very small. One particular protein is only one of millions, and in some instances billions of possible ways of arranging its amino-acids. There must be a selection process which arranges them in the right order.

Biochemical processes, so far as they have been worked out, usually occur step by step and a separate enzyme brings about each step. If there were one enzyme for adding each amino-acid to a growing chain and all were present simultaneously, we should get a mixture of protein molecules in which every conceivable order of the amino-acid molecules occurred.

Actual protein molecules are both varied and specific. There are two kinds of specificity. Most proteins are specific to the organism they come from, and can be differentiated from the similar protein of other species. The pepsins of fish, fowl, pig and ox are all different and can be distinguished by immunological tests. Even hæmoglobins are characteristic of the species they come from. The second kind of specificity is that which enables the protein or enzyme to perform its functions and that, as we have seen, is very rigid.

The enzyme synthesising mechanism must not only be very specific, but it must also provide the energy necessary to form the proteins. There are indications that as in the case of carbohydrate metabolism, phosphate groups are concerned. It is not clear whether there is a sort of ground pattern, a prefabricated protein molecule common to many enzymes, to which groups conferring specificity are added, or whether every enzyme molecule is built up *ab initio* from the amino-acids.

One of the most prolific protein factories is in the mammary glands of the cow, in which great quantities of casein are turned out. Professor Kay has described the process as follows:

"The day's work of one of these cubical cells entails the following cycle of operations. It begins as a rather short squat cell with the nucleus in the middle. Granules or globules, some of which stain with fat soluble dyes, then begin to appear in the part of the cell nearest the alveolar space. The cell begins to increase in length and size, the nucleus remaining fairly close to the basement membrane. The secretory products soon fill the whole of one end of the tall distended cell. These products, and possibly a small part of the cytoplasm, of the cell itself, are now extruded into the lumen . . . as milk, following which discharge the cell returns to its original squat shape. This whole process

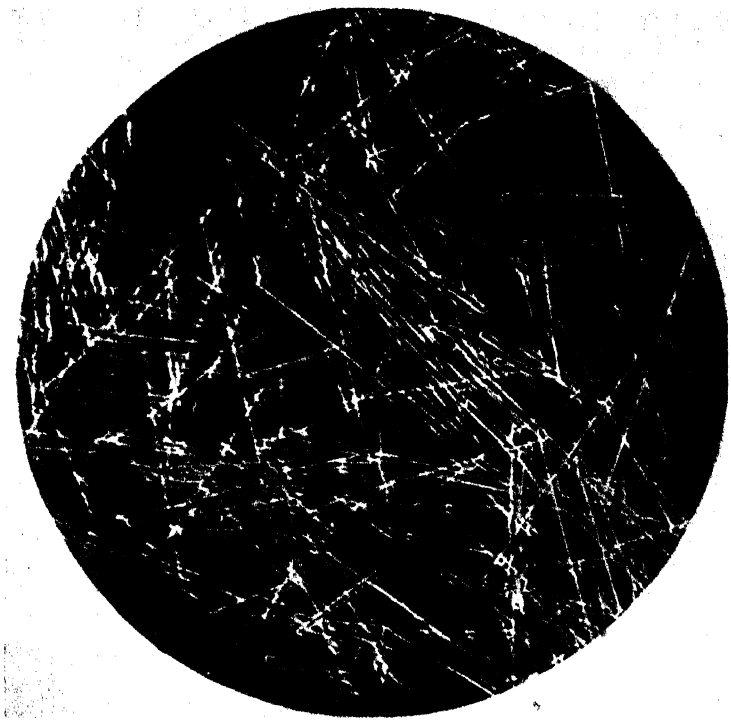


FIG. 24.—*Chymotrypsinogen, the inactive precursor of chymotrypsin*

is repeated several times . . . During twenty-four hours in an actively lactating cow there may be up to four or five or even more cellular cycles in operation".

Now, it is known that the material utilised in the manufacture of the milk protein is mainly the globulin fraction of the cow's blood, but it is not known if the globulin is first broken down into its amino-acids, which are then rebuilt into casein, or if the casein is produced by modification of the globulin. Studies with amino-acids, marked with radioactive "tracers" should enable this to be decided.

It is true that certain enzyme precursors have been isolated. Northrop and Kunitz isolated inactive precursors of trypsin and chymo-trypsin (Fig. 24), Anson of carboxypeptidase and Herriott of pepsin, which are changed into the respective enzymes

by the action of other proteolytic enzymes (or in some cases autocatalytically by the enzyme itself). One might perhaps think that this means that a long series of enzyme precursors may eventually be found, leading back to a kind of undifferentiated protein—stuff from which all are derived. But actually in these cases, it is merely a convenience to the organism to keep the enzyme in an inactive form until it is wanted and the enzyme is actually fully formed in the precursor except for a final step involving the opening up of a few closed bonds or the splitting off of a protective lump of peptide, which blocks the active region.

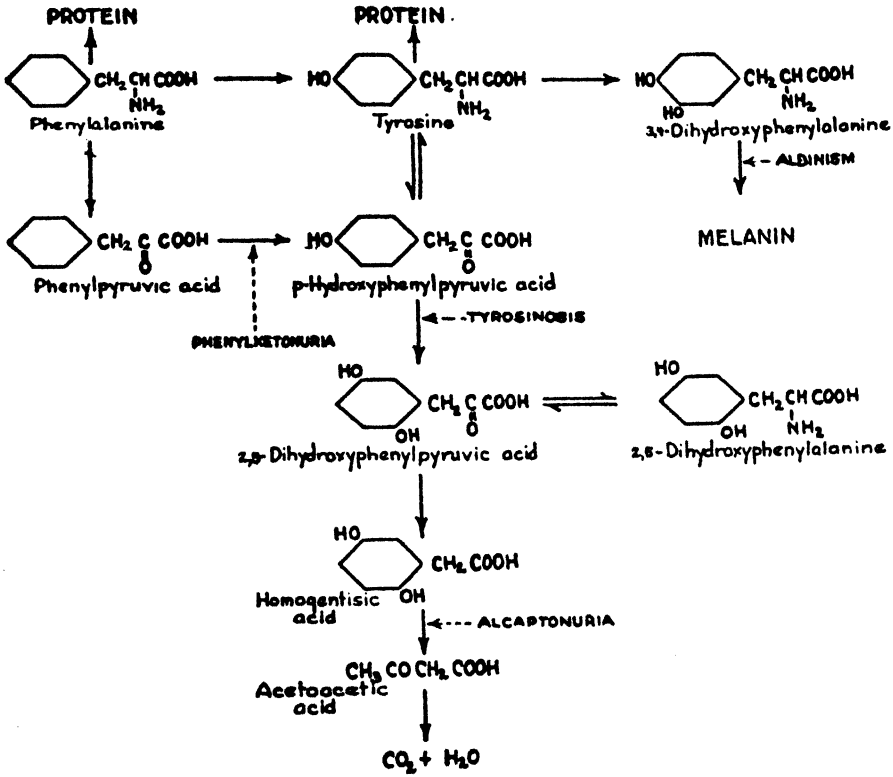


FIG. 25.—*Stages of tyrosine metabolism showing the defect which produces alcaptonuria*

The synthesising process, as I said, must not only be capable of making enzymes; it has also to be able to reproduce itself, and the most promising source of information about it is, in fact, in the study of genetics. Geneticists have termed the unit of heredity, the gene, and it has been established that the genes are normally associated with the chromosomes. Without going into details which are beyond the scope of this lecture, we can say that the Mendelian laws of inheritance can be correlated with the mechanical behaviour of material carried by the chromosomes.

There is a considerable amount of evidence that there is a unitary relation between a gene and an enzyme, *i.e.*, one gene produces, or is responsible for the production of one enzyme. The evidence for this is mostly indirect and consists in the finding in numerous cases that the ability to perform a single biochemical reaction, which

may be one step in an extended series of changes, is governed by the Mendelian laws of heredity. Even in human beings hereditary defects of metabolism are known —for example, the disease known as alcaptonuria, which has been shown to be due to inability of the individual to break down homogentisic acid which is formed in the course of normal breakdown of tyrosine (Fig. 25). It has been shown that the blood serum of normal individuals contains an enzyme which is capable of breaking down this compound, but it is missing in alcaptonurics, with the result that homogentisic acid is excreted in the urine.

The most extensive evidence of this kind, however, comes from the study of moulds. Müller discovered in X-rays a powerful means of inducing mutations, *i.e.*, inheritable changes, in organisms. They are usually negative in the sense that the organism loses the ability to perform some reaction which the un-mutated form was capable of. The mould *Neurospora* is normally capable of growing on a synthetic

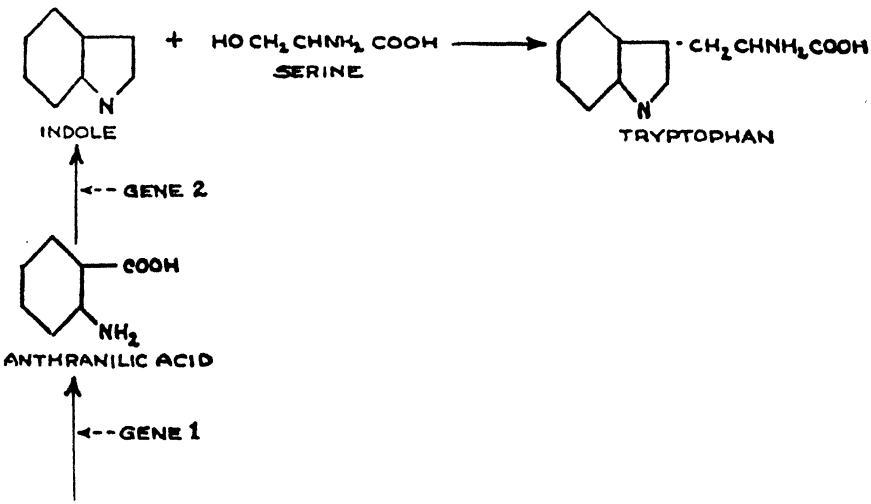


FIG. 26.—*Steps in the synthesis of tryptophane, by Neurospora*

medium consisting of a carbon source (sugar, fats, etc.,), a nitrogen source (nitrate, ammonia, etc.), inorganic salts providing sulphate, phosphate, calcium and potassium and a number of trace elements, and the vitamin, biotin. In a long series of studies on X-ray mutations, Beadle and Tatum have obtained mutants which cannot grow on this minimal medium, but must be supplemented by additional substances, which the mutant organisms are incapable of synthesising for themselves. Strains have been obtained, each differing from the original wild strain by a single gene, each of which fails to grow in the absence of a vitamin, such as thiamin, pyridoxin, *p*-amino-benzoic acid, pantothenic acid, inositol, nicotinic acid and choline. Other strains need amino-acids like arginine, lysine, leucine, valine, tryptophane, etc., and still others require purines, pyrimidines, nucleosides and other materials. In each case genetic tests show that a single gene is missing which controls the synthesis of one particular substance.

For example, in the synthesis of tryptophane several steps have been identified, and mutants have been obtained in which ability to perform one or other of these steps is lacking (Fig. 26). Thus in one strain the ability to change anthranilic acid

into indole is absent, with the results that when indole is provided in sufficient quantity for growth, anthranilic acid accumulates in the medium. In other strains anthranilic acid is not synthesised but they can grow normally if either anthranilic acid, indole or tryptophone are provided. Similar results have been obtained in the bio-synthesis of arginine, choline, and several nucleotides, etc., and with other micro-organisms.

These and many other similar facts support the idea, if they do not prove it, that one gene is responsible for one enzyme. The genes are undoubtedly associated with the nucleoproteins, *i.e.*, the combination of nucleic acid and proteins, which occur in chromosomes and possibly elsewhere; and it is here we must look for the synthesis of enzymes.

As I have already pointed out, a gene must do two things; it must be able to duplicate itself and it must be capable of directing the formation of its enzyme. It is not known whether the gene gives rise to the enzymes directly, or indirectly through the mediation of some intermediate bodies. It is certain that different enzymes are produced in vastly differing amounts, and it is doubtful if a single gene could itself produce one after another all the enzyme molecules of some kinds which the cell turns out. The idea has been widely suggested that the gene either is, or gives rise to, a "template" or mould in which the enzyme molecule is formed with all its parts in their proper relations to each other. What such a template is made of, how constructed and how it does its work can only be regarded at present as one of the mysteries of Nature. The fact that nucleic acid is always associated with the chromosomes has suggested that it may either form or be associated with the template. It certainly has a great, and reversible affinity for many enzymes.

What evidence there is comes mainly from the curious phenomenon of enzyme adaptation. It is a well-established fact that when presented with an unfamiliar food material, some strains of bacteria, yeasts and fungi which originally cannot utilise it, become capable of doing so after a time. There is a lag, which may extend over several cell generations, during which the ability to utilise the new material is gradually acquired. The importance of these facts is undoubted but their interpretation is still being debated.

It is an established fact that presented with a new substrate the organism in some way modifies its enzyme systems so as to deal with it. Does the new substrate induce a new enzyme, which can deal with it, or, has the enzyme always been present, perhaps in minute amounts, waiting for the proper substrate to set in action processes which bring it forth? Or is it perhaps the case that there exist in the population a few cells which have the ability of fermenting the new compound and these are the ones which multiply? These are difficult questions to answer and while a detailed discussion of the various arguments would be out of place, I should like to mention some recent experiments of Spiegelman and others, which seem to me to be important. These experiments are concerned with the growth of yeasts, on the unfamiliar sugar melibiose. The primary fact is that while some strains have the ability to adapt themselves to melibiose, others do not and the ability to do so is a Mendelian character. In other words, there is a gene, the presence of which determines the ability to adapt. In the presence of the new substrate, the adapting cells gradually produce an enzyme, which we may call melibiase, which can break it

down. The non-adapting cells do not. By crossing strains containing the gene and which have been grown in melibiose, with those which do not, we obtain cells which have the ability to ferment melibiose so long as this substrate is present, but when they are deprived of it, the ability is irretrievably lost.

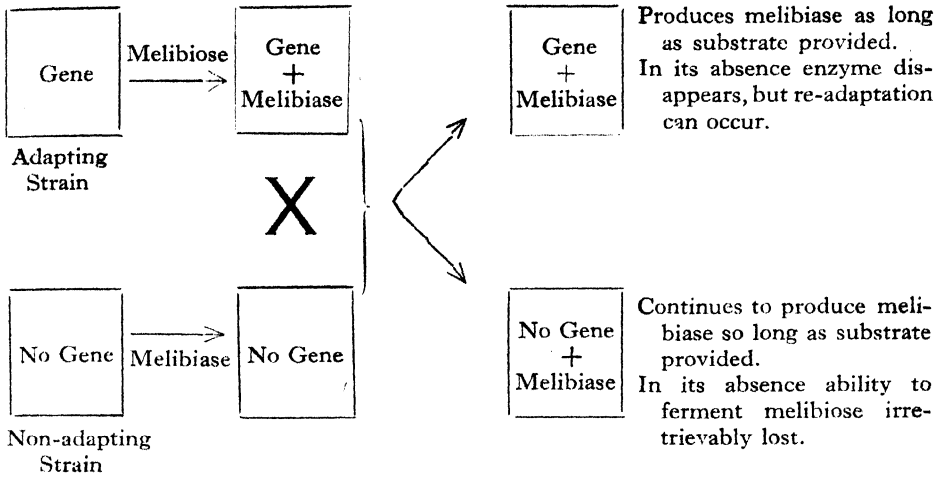


FIG. 27.—*Adaptation to melibiose*

The interpretation of these facts which is suggested is that when exposed to the substrate the gene produces entities which are either copies of the gene itself or some other enzyme-forming body and which can reproduce themselves in the cytoplasm. When crossed with cells containing no gene some of these bodies pass into the cytoplasm of the no-gene cells—which are thus capable of producing the enzyme so long (and only so long) as the substrate is present. When the substrate is removed they are gradually lost.

The presence of particles of nucleoprotein material in the cytoplasm of cells has been demonstrated. It is possible that these are the bodies—either copies of genes, or the products of genes, which produce the enzymes. One can hardly fail to notice the similarity of such bodies with viruses, which also have the ability of reproducing themselves, and of manufacturing enzymes, which as harmful "toxins" make their presence so unfortunate.

Efforts have been made to separate the particulate components of the cytoplasm of both normal and diseased cells. From normal liver cells Claude has obtained a nucleoprotein (containing fatty substances), which he regarded as secretory granules. From diseased cells, as the result of the work of Stanley and others, large quantities of virus protein can be obtained by differential centrifugation in a state of sufficient purity to form regular arrays, which are quite properly regarded as crystals.

This takes me to the limit of my subject and I conclude my survey of enzymes by Table IX, which shows their place in the hierarchy of natural structures. Coming as they do between the simple primary compounds and the complex structures they occupy a very strategic position. As a result of their isolation and purification they are now accessible to investigation by the structural chemists and the physicists, and since they are the simplest structures peculiar to life, they are at the present time the frontier where the various studies meet.

TABLE IX

HIERARCHY OF NATURAL STRUCTURES

		Weight × H
Higher Organisms	Man	10^{28}
	Animals	
	Plants	
Cells	Protozoa	10^{10}—10^{14}
	Amoebae	
	Red blood cells	
	Fungi	
	Bacteria	
Nucleoproteins	Genes	10^{7}—10^{9}
	Bacteriophage	
	Cytoplasmic bodies	
	Viruses	
Proteins	Antibodies	10^{4}—10^{6}
	Toxins	
	Enzymes	
	Globulins	
	Albumins	
	Protamines	
Peptides	Inhibitors	10^{2}—10^{4}
	Gramicidin, etc.	

Amino-acids (and other simple organic compounds).

In order to give some impression of the wide ramifications of present-day enzyme studies, I have gone far outside the field in which I can speak with the authority of personal experience. The fact is that no single specialism is wide enough to cover all the facets of enzyme research.

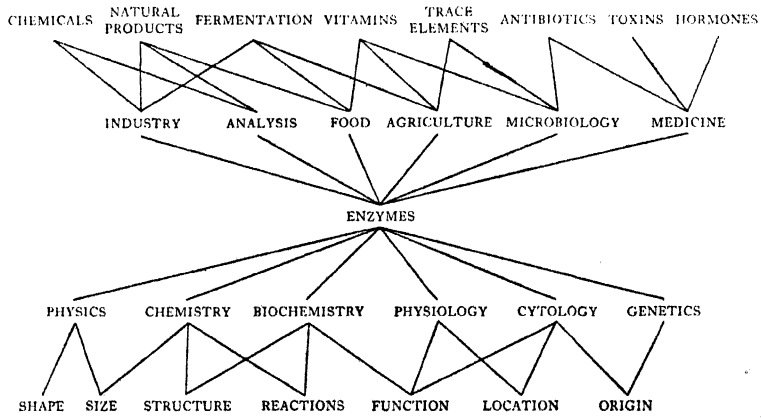


FIG. 28.—*The sciences which contribute to knowledge of enzymes and human activities in which enzymes play a part*

In my final illustration, Fig. 28, I have tried to give some idea of the ramifications and applications of enzyme studies. The methods of research involve all the fundamental sciences and the applications, as we have seen, cover most human activities—medicine, agriculture, nutrition, industry. There is no better illustration of how the barriers between the sciences have broken down. Certainly the older divisions between organic, physical and bio-chemistry have lost much of their significance in this field. It is inevitable that chemists and physicists in the future will be more concerned with the living structures—and enzymes and other proteins come first in the list of problems for investigation. They are ready for the application of every resource which can be brought to bear on them. There is no doubt, I think, that their structure is at present an accessible, if difficult, goal.

ACKNOWLEDGMENTS

I wish to express my gratitude to the following for the permission they have so kindly given me to reproduce illustrations, etc.: Drs. J. H. Northrop and M. Kunitz and the Columbia University Press (Figs. 2, 4, 24); Professor J. B. Sumner (Fig. 1); Dr. M. Kunitz (Figs. 9, 11); Dr. M. Perutz (Fig. 10); Dr. D. Glick (Fig. 23); Dr. B. C. J. G. Knight (data shown in Fig. 22); Dr. W. W. Pigman (Fig. 17). Dr. G. Pontecorvo kindly read Lecture III and gave me the benefit of his comments, but he is, of course, in no way responsible for any of my statements.

NOTES ON BOOKS

CASTE IN INDIA. By J. H. Hutton. Cambridge University Press, 1946.

The author of this latest attempt to deal with the nature of Indian caste and its much disputed origin is already well known to scholars for his interesting researches into certain Nāga tribes on the north-eastern frontier of India—a primitive people whose custom it is to offer human skulls to their prospective brides in place of the more readily procured engagement rings of Western civilisation. Dr. Hutton, as Census Commissioner for India in 1931, was in a position to add considerably to his previously acquired knowledge of Indian customs; and has thus been able to compile a most valuable summary, dealing comprehensively with this vast subject in 166 pages.

Starting with a brief description of the leading tribal and caste divisions in all parts of India, in order to illustrate the diversity of the subject-matter (Chapters I to IV), he next considers, in Part II " the structure, strictures, sanctions and functions" of caste. Part III deals with the much disputed question of caste origin, both the existing theories on the subject and also parallels from other times and countries where something resembling a caste organisation has been recorded. The two appendices deal with low castes and with the reaction of primitive religion to Hinduism, and *vice versa*.

To do full justice to a work of this nature it would be necessary to write another volume of similar length. Failing this, it is possible only to summarise Dr. Hutton's leading points and to offer a few suggestive criticisms. On p. 165 will be found fifteen probable factors in the emergence and development of the caste system. So ample a theory of composite causes avoids the pitfall besetting many previous writers such as Nesfield, Senart, Risley and others. These have laid too much emphasis on race, occupation, residence or other factor that has played a part, but only a part, in caste origin. It seems venturesome to attempt to add in any way to Dr. Hutton's "fifteen points"; but in this connection there is room for a passing reference to the general Indian failing, referred to by him on p. 102,

i.e., "the quite disproportionate importance attached to trifling differences arising from one reason or another on the conduct of small groups or individuals". It has been suggested elsewhere that this can possibly be traced to climatic and geographical causes, the *milieu* of Dr. Finot, which are influences of potent value in the formation of character. Viewed broadly, from outside, caste consists of a larger group of which the members may marry only inside the circle, *i.e.*, a so-called endogamous unit, and, within this circle, a number of smaller groups, of which the members must marry outside the group, *i.e.*, an exogamous section.

Recent research in the course of the Ethnographical Survey of many provinces has brought to light, in a large number of instances, a definite totemistic basis, commonly animals, trees, fruit, etc., for these exogamous sections. Many hundred totems are now on record. This is in harmony with the general trend of Dr. Hutton's conclusions, since he looks to pre-Aryan India very largely for the original basis of the caste system. Perhaps a little more space might usefully have been given to discussing the probable overseas source of totem worship described on p. 195 as proto-Australoid. Next in importance to Chapter X on caste origins is Chapter VIII dealing with the functions of caste as a social institution. Both the disadvantages and the value of the system are clearly and accurately described, attention being specially drawn to the rôle played by caste as a stabilising element in Indian society. As the writer points out, dissatisfaction with inherited social status is hardly probable when the doctrine of *Karma* not only justifies the existing status of the individual but offers a ready prospect of promotion in the course of future incarnations.

Enough has now been written to convince the student that this is a work of first-class importance, requiring careful study from cover to cover. For reasons of space, we are able only to offer a few minor criticisms. The author's reversion on p. 18 to a now abandoned derivation of Maharashtra from Mahar both rejects the recorded views of eminent philologists and ignores Bhandarkar's more suggestive comparison of Maha-Bhoja and Maha-Ratta, in which a more suitable derivation is to be found. The confusion of the Gujarati Kanbis (p. 17) with the Kunbis of Maharashtra is hardly justifiable. The two have nothing in common but their occupation of agriculture, and are really racially distinct.

Dr. Hutton is difficult to follow in his attempt to re-christen the lower or out-caste section of the population by re-naming them "exterior castes". He seems to aim at avoiding confusion between "outcast" and "outcaste". Exterior, however, is merely a top-heavy form of "out", and if the official designation of "Scheduled castes" is to be rejected as carrying no definite meaning it would surely be best to revert to the easily understood name of low caste, avoiding a cumbersome substitute for outcaste. In the description of caste structure on p. 129 we do not find any reference to the convenient provision made for the issue of cross marriages, *i.e.*, for example, of a caste bridegroom with a bride of a lower order. Full caste status being denied, a new sub-division arises, known frequently by a numerical description such as *akaramase* (eleven measures instead of a full twelve) or *visa*, *dasa* and *panch* (twenty, ten, and five), showing increasing admixtures of blood. In time, full caste status can be regained.

In Appendix B, dealing with primitive religion, some reference to the well known papers of Sir James Campbell on "The spirit basis of belief and custom," which are helpful in explaining many of these primitive customs, would have been valuable. Spirit propitiation and spirit scaring afford a clue to the beating of sick persons, the marriage of bachelors to totems before marrying a widow, the marriage to trees of persons dying unwed, and the special dread of the widely feared *alvantin*, *i.e.*, the spirit of a mother who has died in childbirth. In this connection it may be noted that an exact parallel to the case of murder by exorcists, quoted on p. 230, is to be found in the Introduction to the "Folk Lore of Bombay".

Dr. Hutton prefers the term soul-substance to Campbell's spirits, for which an ancestral origin is assumed. The difference seems to be largely a matter of words, spirit and *mana* being similar if not identical.

In the interesting suggestion (p. 115) that marriage restrictions as prescribed by caste custom are the cause of the excess of males which is a notable feature of the population of India as a whole, some passing reference to the share attributable to female infanticide still not uncommonly practised, though hard to detect, might have been made. A useful glossary of terms not explained in the text follows an ample bibliography. It should be noted that *Bedas* (or *Boyas*), once a fighting caste as therein described, are nowadays village watchmen, and seem identical with the *Ramoshi*, who are well known in that occupation. *Lingāyat* is not accurately a caste, it is more correctly a sect of Shiva worshippers, anti-caste in origin, but containing numerous castes in its lower orders. As a religious body, the higher sections alone are entitled to the full rites of this peculiar form of *linga* worship, rites comprehensively known as *Ashtavarna*. On p. 204 a very original theory is advanced for the well known practice of showing religious and caste distinctions by marks borne on the forehead. It is plausible to suggest that the mark may have been protective; but the Vaishnava and the Shiva sects seem clearly to aim primarily at suggesting by the vertical and horizontal lines their devotion to Vishnu and Shiva.

We would sum up this appreciation of this valuable work by warmly congratulating the author on the admirable exposition of a most complex subject, combining brevity with clarity. It is hardly possible to find a definition of caste in a limited number of words bearing any concise significance and covering the almost endless variations commonly recognised. In this book, however, caste is explained in simple language. The text should form a handbook for those who desire to acquaint themselves with the extraordinarily complicated structure of Indian society.

R. E. ENTHOVEN.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

TUESDAY, SEPTEMBER 30..Textile Institute, at the Nicholson Institute, **Leek.** 8 p.m. H. G. Greg. **"Fancy Yarns—Their Production and Use."**

WEDNESDAY, OCTOBER 1..Physical Society, at the Imperial College of Science, S.W.7. 3.30 p.m. J. G. Holmes and R. G. Horner, **"The International Colour-Vision Conference."**

Public Analysts, Society of, at the Chemical Society's Rooms, W.1. 6 p.m. (1) Bernard H. Howard, **"The Determination of Small Amounts of Hexachlorocyclohexane (Benzene Hexachloride)."** (2) J. H. Skellon and E. D. Wills, **"Iodimetric Methods of Estimating Peroxide Oxygen."** (3) B. Bagshawe and J. D. Hobson, **"A Study of the Cobalt-Ferricyanide Reaction with relation to the Determination of Cobalt in Steel."**

THURSDAY, OCTOBER 2..Auctioneers' and Estate Agents' Institute, 29 Lincoln's Inn Fields, W.C.2. 6 p.m Henry W. Wells, **"The Management of Publicly Owned Land."**

Chemical Society, Burlington House, W.1. 7.30 p.m. Professor F. G. Donnan, C.B.E., F.R.S. **The Ernst Julius Cohen Memorial Lecture.**

Textile Institute, at the Electricity Showrooms, Darwen Street, **Blackburn.** 7.15 p.m. F. Millard, **"The Properties of Nylon and its Processing from the Weaving Point of View."**
At the Midland Hotel, **Bradford.** 7 p.m. Sir E. Raymond Streat, **"Textile Problems of To-day."**

FRIDAY, OCTOBER 3..Physical Society, at the Imperial College of Science, S.W.7. 3 p.m. (1) Dr. H. H. Hopkins, **"The Optical Sine Condition and Herschel's Condition."** (2) E. Wolf, **"Eikonal Theory and Aspheric Systems."** (3) Dr. H. H. Hopkins, **"Disturbance near the Focus of Waves of Radially Non-uniform Amplitude."**

Sanitary Institute, Royal, at the Town Hall, **Chester.** 10.45 a.m. (1) Arnold Brown, **"The Administrative Aspects of the Care of Children."** (2) Charles Greenwood, **"The Replanning of an Ancient City.'**

MONDAY, OCTOBER 6..Arts, Royal Academy of, Professor A. B. Appleton, **"Anatomy."** (Lecture I.)
Textile Institute, **Manchester.** 7 p.m. S. W. Barker and R. Alleston, **"The Nelson Process."**

TUESDAY, OCTOBER 7..Chadwick Trust, at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, W.1. 2.30 p.m. Brigadier A. E. Richmond, C.B.E., **"Positive Health—its attainment in the soldier, and the Army's contribution to it in the Civilian."**
East India Association, at Over-Seas House S.W.1 2.30 p.m. Dr Oskar Spate, **"The Boundary Award in the Punjab."**
Kinematograph Society, British, at the Manchester Geographical Society, 16 St. Mary's Parsonage, **Manchester.** 10.30 a.m. A. E. Amor, **"The Manufacture of Motion Picture Film."**
In the Neville Hall, Neville Street, **Newcastle-on-Tyne, 1.** 10.30 a.m. C. G. Heys Hallett, **"Some Special Purpose Arcs."**
Mechanical Engineers, Institution of, S.W.1. 6 p.m. S. Markland and N. Tattersall, **"High Speed C.I. Engines."**
Textile Institute, at the Municipal Technical College, Manchester Road, **Bolton.** 7.30 p.m. J. Shepherd, **"British Export Trade under Post-War Conditions."**

WEDNESDAY, OCTOBER 8..Arts, Royal Academy of, W.1. 4 p.m. Professor A. B. Appleton, **"Anatomy."** (Lecture II.)
Kinematograph Society, British, at the G.B. Theatre Film House, Wardour Street, W.1. 7.15 p.m. Arthur, Krestin, **"The Law of Copyright and the Film."**

THURSDAY, OCTOBER 9..Asiatic Society, Royal, 56 Queen Anne Street, W.1. 4.30 p.m. Bishop Stephen Neill, **"The Beginnings of Tamil Literature."**

Town and Country Planning Association, 28 King Street, W.C.2. 1.15 p.m. Mr. E. Geoffrey Parsons, **"Farming Policy for Agricultural Belts of New Towns."**

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JOURNAL OF THE ROYAL SOCIETY OF ARTS

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VISIT OF H.R.H. THE PRINCESS ELIZABETH

The Council have great pleasure in announcing that H.R.H. The Princess Elizabeth has consented to attend the Inaugural Meeting of the new Session, which will take place at the Society's House on Wednesday, November 5th, at 2.30 p.m. The President will re-open the Lecture Hall, the repair of which is now almost completed, and the Chairman of Council, Sir Harry Lindsay, will deliver his Inaugural Address.

Owing to the anticipated demand for seats, only one ticket can be issued to each Fellow, for his personal use. The method of allotment will be decided by the Council at their meeting on Monday next, and will be announced in the next issue of the *Journal*. In the meantime, Fellows desirous of attending are advised to notify the Secretary without delay.

MEETINGS OF THE SOCIETY BEFORE CHRISTMAS

Ordinary Meetings

(Fellows are particularly requested to note the amended time of these meetings)

Wednesday, November 5th, at 2.30 p.m.—Opening of the 194th Session. H.R.H. The Princess Elizabeth, President of the Society, in the Chair. Inaugural Address: "Cultural Relations within the British Commonwealth". By the Chairman of the Council, Sir Harry Lindsay, K.C.I.E., C.B.E., Director of the Imperial Institute.

Wednesday, November 12th, at 2.30 p.m.—"Craftsmanship" (i) "The Crafts—Their Past, Present and Future". By John Farleigh, A.R.E. A. E. Richardson, R.A., F.R.I.B.A., Professor of Architecture, Royal Academy Schools, in the Chair.

Wednesday, November 19th, at 2.30 p.m.—"The Development of Sound Recording and Reproduction". By Sir Ernest T. Fisk, Managing Director, Electric and Musical Industries, Ltd. (With demonstrations.) Sir Noel Ashbridge, B.Sc., M.I.E.E., Deputy Director-General, British Broadcasting Corporation, in the Chair.

Wednesday, November 26th, at 2.30 p.m. (*Selwyn Brinton Lecture.*) "Originality in Italian Renaissance Architecture". By R. A. Cordingley, M.A., F.R.I.B.A., M.T.P.I., Professor of Architecture, Manchester University. (Illustrated by lantern slides.)

Wednesday, December 3rd, at 2.30 p.m.—"Craftsmanship" (ii) "The Contemporary Studio-Potter". By Bernard Leach. (With illustrations.)

WEDNESDAY, DECEMBER 10TH, at 2.30 p.m.—"SCIENCE AND THE FISHING INDUSTRY". By Michael Graham, Officer-in-Charge, Ministry of Agriculture and Fisheries Laboratory, Lowestoft. (Illustrated by lantern slides.)

INDIA AND BURMA SECTION

THURSDAY, DECEMBER 4TH, at 2.30 p.m. (*Joint Meeting with the Royal India Society*).—"INDIAN ART—WITH SPECIAL REFERENCE TO THE EXHIBITION AT BURLINGTON HOUSE". By Basil Gray, M.A., Keeper of Oriental Antiquities, British Museum. Field-Marshal Earl Wavell, P.C., G.C.B., G.C.S.I., G.C.I.E., C.M.G., in the Chair.

DOMINIONS AND COLONIES SECTION

TUESDAY, NOVEMBER 18TH, at 2.30 p.m. (*Neil Matheson McWharrie Lecture*).—"SCIENTIFIC RESEARCH IN CANADA AND ITS LINKS WITH SCIENCE IN THE UNITED KINGDOM". By Dr. J. G. Malloch, M.B.E., Chief Scientific Liaison Officer with the High Commissioner for Canada. Sir Edward G. Appleton, G.B.E., K.C.B., F.R.S., Secretary, Department of Scientific and Industrial Research, in the Chair.

TUESDAY, DECEMBER 16TH, at 2.30 p.m.—"AUSTRALIAN ART". By Colin Colahan.

CANTOR LECTURES

MONDAY, NOVEMBER 10TH, at 4.30 p.m.—"MODERN DANISH DESIGN". By Steen Ejler Rasmussen, HON.R.D.I.

MONDAY, NOVEMBER 17TH, at 4.30 p.m.—"THE EFFECT OF ADVERTISING ON COMMERCIAL DESIGN". By Ashley Havinden, R.D.I.

MONDAY, NOVEMBER 24TH, at 4.30 p.m.—"EXHIBITION DISPLAY". By James Gardner, O.B.E., R.D.I.

FACULTY OF ROYAL DESIGNERS FOR INDUSTRY

VISIT TO SCOTLAND

An interesting event and the first occasion of its kind for the Faculty of Royal Designers for Industry, took place from September 18th to 20th when a party of members of the Faculty paid an official visit to "Enterprise Scotland", the exhibition of design organised by the Scottish Committee of the Council of Industrial Design, in Edinburgh, and to various manufacturing plants in Scotland. The visit was arranged by the Scottish Committee and the party consisted of Sir Harry Lindsay, K.C.I.E., C.B.E., Chairman of Council of the Society and *ex officio* President of the Faculty, Mr. S. Gordon Russell, C.B.E., M.C., R.D.I., Master, Mr. Reco Capey, R.D.I., Mr. James Gardner, O.B.E., R.D.I., Mr. Robert Y. Goodden, R.D.I., Mr. Milner Gray, R.D.I., Mr. Brian O'Rorke, A.R.A., R.D.I., Mr. R. D. Russell, R.D.I., Mr. Percy Delf Smith, R.D.I., Mr. Allan Walton, R.D.I., Miss Anna Zinkeisen, R.O.I., R.D.I., and Mr. K. W. Luckhurst, Secretary of the Society and the Faculty.

The first and primary function of the visit was the tour of the exhibition, which was conducted by Sir Steven Bilsland, Chairman of the Scottish Committee, Lady McGregor of McGregor, a member of the Committee, and Mr. Basil Spence, architect of the exhibition. Mr. Gordon Russell, R.D.I., and Mr. James Gardner, R.D.I., both played a dual rôle as host and guest, the former being Director of the

Council of Industrial Design and Master of the Faculty, the latter being the designer of the exhibition as well as a member of the visiting party. Another member of the party, Mr. Robert Goodden, R.D.I., was also responsible for part of the exhibition display. After touring the exhibition the party were entertained to luncheon by the Lord Provost and the subsequent 48 hours were taken up in a most interesting and comprehensive series of visits to various Scottish industries, including ship-building (John Brown's Shipyard), woollen textiles (D. Ballantyne Bros. & Co., Ltd.) printing (R. & R. Clark, Ltd. and W. & A. K. Johnston, Ltd.). precision instruments (Kelvin, Bottomley & Baird) and mass-production of furniture (H. Morris & Co., Ltd.). The party were throughout two busy days received with traditional Scottish hospitality and were entertained to dinner on the Thursday and Friday evenings by the British Council and Scottish Committee respectively. The thanks of the party are particularly due to Sir Steven Bilsland, and to Lady McGregor, who was personally responsible for the planning of the tour and accompanied the party throughout the visit.

WAR MEMORIALS ADVISORY COUNCIL

On Wednesday, October 1st, the Prime Minister received a deputation from the War Memorials Advisory Council, who raised the question of a National War Memorial which might perhaps have Commonwealth and Empire support.

The deputation consisted of the following :—

Lord Chatfield (*President*).
Miss Margaret Bondfield.
Sir Harry Lindsay.
Mr. J. A. Milne.
Mr. Harold Nicolson.
Lord Wigram.
Mr. A. R. N. Roberts (*Hon. Secretary*).
Mr. J. Samson (*Executive Officer*).

The Prime Minister undertook to give consideration to the views expressed on behalf of the Council.

INTERNATIONAL GOTHIC AND ITALIAN PAINTING

By Sir KENNETH CLARK, K.C.B.
Slade Professor of Fine Art, University of Oxford

SELWYN BRINTON LECTURE

Ordinary Meeting, Wednesday, June 11th, 1947.

Professor T. S. R. BOASE, *Director, Courtauld Institute of Art, in the Chair*

THE CHAIRMAN: The lecture this evening is the first to be given on a new foundation. That foundation is a bequest from the late Mr. Selwyn Brinton, a bequest which is administered by the Royal Society of Arts, but was left for the use of the British Academy at Rome. In the event of the British Academy at Rome not being able to make

use of that bequest for awards, which has in fact been the case during the War, it was the wish of the donor that it should be used here for purposes connected with the Italian Renaissance, and in particular for lectures on that subject. It was a subject to which Mr. Selwyn Brinton himself, as probably you know, directed a great deal of his time. His "History of Italian Renaissance Art" was written between 1898 and 1900, a long work in nine volumes, and he continued to work on the subject throughout his life. His book on Francesco di Giorgio is characteristic of the way in which he maintained his interest in these studies, as Francesco is an artist whose full importance has only recently been realised. That was his last book, published in 1934.

I do not think that the desires of the founder of this course of lectures could be better implemented than by having Sir Kenneth Clark here to lecture to us to-night. The great masterpieces of art and the great periods of history have to be re-interpreted in every generation. However much you write about them, each generation will find that they seek something new from them. There is no doubt that to us in England to-day Sir Kenneth Clark is the interpreter of what the Italian Renaissance means. He has taken as his subject the relation between International Gothic and Italian Renaissance Art, a subject which is right in the forefront of renaissance studies. At one time it was sought to put the history of art into watertight compartments, but we know now that a great deal of the interest of the subject is not in these sharp distinctions, but in a much more composite synthesis.

I ask Sir Kenneth Clark to talk to us on this subject.

Sir KENNETH CLARK then read the following paper :

Mr. Selwyn Brinton, the founder of the lecture which I have the honour to give this afternoon, was one of those scholars who believed that the understanding of the Renaissance should not be confined to a small group of specialists, but should be an integral part of our sense of values. It is in this spirit that I am now going to look at a critical problem in the history of Renaissance Art: how much Italian painting owes to the style which is generally referred to as International Gothic. In case some of you are not familiar with the language of art history, I should explain that this term was invented by the French historian Courajod to describe the new spirit which animated Gothic art about the year 1390. In fact, this new vision of Gothic is no more international than the Ile de France Gothic which preceded it, but the term has passed into general currency and its use is justifiable. What this new spirit was we shall see most clearly if we approach it historically. First, let me characterise the Italian art which it was to influence.

The revival of painting in Italy was a Byzantine and Latin movement. On the one hand it was the result of works of art (or artists) imported from Constantinople, on the other of the study of Roman paintings, and some remains of an old Tuscan tradition. The first great Gothic movement—which I have called the Ile de France Gothic of the thirteenth century—had a certain influence on the constructional problems of Italian architecture, a slight influence on sculpture, but absolutely no influence on painting. At the height of Gothic influence in Western Europe Giotto is practically untouched by Gothic rhythms. Even the Franciscan movement was recorded by Giotto with a Roman massiveness, which is very remote from the graceful—we may even say playful—spirit of the *Fioretti*. Giotto's frescoes are essentially static, St. Francis and Gothic art are ecstatic. St. Francis's love of all created things is reflected in the beautiful naturalistic carvings of thirteenth century Gothic masons at Rheims or Southwell; but Giotto's grand heroic ideal of

art allowed no enchanting details of this kind to distract from the formal architecture and dramatic economy of his compositions.

In Siena, where from the first Constantinople and not Rome had been the dominating influence, a less austere spirit was soon evident. The German historian Worringer argued with great insight that Gothic art was the true continuation of Greek as opposed to Roman—the art of rhythmic movement as opposed to the art of monumental stasis. The earliest Italian painting to show Gothic influence—this Duccio Madonna with three kneeling Franciscans—supports his argument, for it is almost a perfect mixture of Byzantine Greek and Gothic elements. The type of the Virgin and Child is pure Byzantine, but the diapered background is derived from a thirteenth-century French manuscript which had found its way to Siena, together with Limoges enamels, English embroideries and other decorative arts, in which at the time the North excelled.

Now it was the greatest Sienese painter of the next generation, Simone Martini, whose influence on French art was to create the so-called International Gothic. In his very beginnings his style was Byzantine, but as early as 1315 Gothic elements appear, and by the middle of his life he had created a new grace of line which was entirely his own. His colour also has a new richness and variety, and he took an especial delight in the texture of materials. Simone was the first sensuous painter of the Middle Ages. It was perhaps inevitable that he should find his way to Avignon, for Provence—the home of the Troubadours and the Albigensians—had always been the erring daughter of the medieval world, and the Papal Palace of Avignon, standing outside both the feudal and the orthodox religious structure of the Middle Ages, had achieved a sort of prophetic irresponsibility. No wonder that Marxist historians have seen in it the origins of the luxury and capitalism of post-medieval society.

Simone arrived in Avignon in 1339, and remained there till his death in 1344. It was a critical period in French Gothic, when the enchanting style of the late thirteenth century had become rather mannered and formalised. Compared to these elegant linear symbols, Simone's compositions must have looked marvellously rich and passionate, and his figures surprisingly corporeal. The fair skin and regular features of his Madonnas and Angels provided an ideal of physical beauty which was to survive for almost a century.

The influence of Simone on northern art was delayed by the Black Death and the Hundred Years' War, but it is still clearly perceptible when we come to the creation of the international Gothic style almost fifty years later. Indeed, many compositions in French manuscripts are taken direct from Simone as late as about 1400. The scene of this creation was the Courts of the three great dukes, brothers of Charles V, Philip, Duke of Burgundy, John, Duke of Berry, and Louis, Duke of Anjou, and is a notable instance of the importance of patronage in an artistic movement. But, although the patrons were French (in so far as the word meant anything at the time) the artists all come from the Netherlands, and were the first wave of that phenomenal tide of genius which flowed from that small, flat corner of Europe during the fifteenth century. Broederlam, Sluter, de Limbourg, de Hesdin, Van Eyck, show their origins in their names, but even Beauneveu came from Hainault and Bellechose from Brabant.

The earliest dated painting which survives from this group of artists is the altar-piece painted for the Champmol of Dijon by Melchior Broedeerlam in 1393. In it international Gothic appears complete with nearly all its repertoire, and we are left to guess at the intervening stages during which these were being evolved. We notice a new sense of reality in the figures (for example, the Virgin's head and the Joseph drinking) a profusion of flowers, and a new sense of space. This is not so remarkable in the landscape, where the old Byzantine convention of fantastic rocks prevents recession, as it is in the architectural interiors and in the relation to the figures. In the Anunciation there is even a playing with space, these rhythms of spatial direction being a sort of complement to the fanciful linear rhythms of the late Gothic.

This sense space is charmingly illustrated in one of the few other pictures of the period to survive—a diptych in the Van den Bergh Museum at Antwerp. The left-hand wing is traditional—still Sienese—but the right is almost the first poetic landscape of modern painting. The painter has not only observed the details of Nature, but has become absorbed in the mood of the whole scene.

This new confidence in Nature is certainly one of the great discoveries of international Gothic. To the early medieval mind Nature had seemed like a huge, hostile forest, full of unknown terrors. But by 1390 there is a clearing in the forest; the birds and rabbits are friendly; it is no longer sinful to take delight in the flowers and picnics become fashionable. Above all there is hunting. The pleasures of hunting, which was the chief—practically the only—occupation of leisure during the late Middle Ages, was one of the chief means by which man overcame his fear of Nature, and is reflected not only in a greater interest in landscape, but also in a curiosity about animals of all sorts. Probably the art in which this spirit was given fullest expression was tapestry, but of this we can form only an idea, for practically all the secular tapestries of the fourteenth century are lost to us. We know that they decorated every castle and palace; but castles and their contents were more frequently destroyed than ecclesiastical buildings. So to judge of this courtly aspect of international Gothic we must look at tapestries of the fifteenth century, which survive in large numbers, and relate them to those pages of earlier manuscripts in which profane subjects were admitted, that is to say, the calendars. The illuminators of these pages came from a country of fact—from bourgeois communities where facts count; they worked for aristocrats who demanded the highest degree of decorative richness. The combination of the two created that culminating masterpiece of the style, the *Très Riches Heures* of the Duke of Berry, the latest and most sumptuous of the books done for this great bibliophile. Here we see the elegance of this courtly style, with its love of dressing up and its leisurely enjoyment of the delights of Nature. We are still at the edge of the forest, but the trees are quite small. The feeling for landscape has made an incredible advance in the ten years or so since Broederlam's altar-piece, and in places is almost as factual as a Breughel.

This naturalism is not confined to landscape; it is also applied to the individual human being. Here again we have a link with Simone Martini, because he was certainly one of the first artists to portray individuals, and actually painted a portrait of the first great individualist, his friend Petrarch. But it was with fact-loving

Flemish artists at the Courts of France and Burgundy that portraiture became usual. Charles V's long nose is the first individual feature to become familiar to us since classical times; and almost the first large portrait painted for its own sake is Burgundian. It is a light on our subject that although the Burgundian origin of this portrait can be shown quite conclusively (in fact I think it is probably by Broederlam himself), it passed until quite recently as a Pisanello.

But beside this interest in the individual human face lies the creation of a new type of beauty. The position is well shown in the frontispiece of the *Très Belles Heures* of the Duke of Berry (a book which seems to antedate the *Très Riches Heures* by about fifteen years, and is still full of Simone's influence), where the far from beautiful features of the Duke are smoothed out and idealised, while still conveying a recognisable likeness. Fifty years earlier he would have been represented as an abstract type of ruler and patron, with no attempt at likeness at all; fifty years later this would have been a realistic portrait with no attempt at idealisation. What this new type of beauty was like without the inhibiting factor of likeness, may be seen from these drawings of heads from a sketch book attributed to Andre Beauneveu. They are modelled with a real delight in the smooth texture of a fresh complexion.

I have spoken so far as if the new style were concerned solely with profane subjects. That it concerned itself with life on earth far more than had been usual during the last 700 years is true. But nothing in the Middle Ages is independent of religion, and in fact international Gothic is very largely the expression of a new religious sentiment. Gothic art has been described as a balance between scholasticism and mysticism. The late thirteenth century, the great period of scholasticism, produced a schematic, intellectual art. After the Black Death, scholasticism, and all forms of schematised order—feudalism, legalism—decline, and a new period of mysticism begins. It is the sensuous mysticism of the soul as *microtheos*, which believes that the divine is not outside the world, but is contained in the world. This springtime in the soul, which becomes, in fact, a springtime in the senses, is expressed not only in a new delight in Nature, but *in a new rhythm*, a warm sensuous flow, entirely different from the sharp, clear abstracted rhythms of the early fourteenth-century Gothic. From a hundred possible examples I may choose this sweet Madonna and Child full of Simone's influence, but yet one of the first truly French works of art. It has the candid delight in prettiness of a Renoir—even the dark tones of the eyes remind us of his work. And this warmth of life is expressed by the flowing rhythm of gesture and drapery. One more example, the so-called Pahler altar of a South German artist, shows this sensuous rhythm combined with mysticism, a combination which is always re-appearing in the ecstatic epochs of Christianity.

But the strangest and most delightful mingling of the sensuous and mystic elements in international Gothic is the *hortus conclusus*. This enchanting subject combined the pleasures of flowers and picnics with an elaborate symbolism setting forth the virtues of Our Lady. As if the heathen wilderness were still a menace Our Lady and her Son are placed in an enclosed garden, a little enclave of peace and gentleness in a savage world. Sometimes the garden is very small, only a symbol of enclosure, as in the sweet Christmas cards of Stephen Lochner. But

sometimes they are large paradise gardens, as in this adorable work of a South German artist which used to be in Cologne. There can, I think, be little doubt that they are inspired by Persian miniatures which had found their way to Europe, either through Venice or through Spain. The Garden with all its delights of peach trees, pergolas and fountains was a Persian invention—only there the oasis it makes is an escape from the sun rather than the forest. The example before you contains all the elements of international Gothic in their sweetest form—the fountains, the birds on the battlements, the flowing gestures, the flowery coronals, the Holy Child Himself making music, and the dragon of Evil, never very formidable, lying with his tummy in the air. Nothing could be further from the monastic ideal of the earlier Middle Ages, by which, as St. Anselm maintained, things were harmful in proportion to the number of senses they delighted, and it was particularly dangerous to sit in a garden where there are roses to satisfy the senses of sight and smell and music to please the ears.

Such then are the characteristics of international Gothic: a new confidence in Nature, a delight in the accurate representation of natural details, whether of flower, bird or the human face; an aristocratic appetite for hunting, picknicking and dressing up; a new type of physical beauty, and a sweet flowing rhythm to express that sensuous mysticism which preceded, and in a measure prepared, the Reformation.

Let us now see how these characteristics affected Italian painting. In North Italy their influence was overwhelming. The local painting of the fourteenth century had been almost entirely provincial, feeble and hollow symbols adapted from the style of Giotto; and where it evinced some individual talent, as in Altichiero and Giovanni da Milano, it showed an interest in particularity, in graphic detail which went half way to meet the new Burgundian realism. By 1400 Lombard and Veronese painting was already interpenetrated with Northern miniature painters, and had become practically a department of the international Gothic style. The frescoes in the Castle of Trent show the calendar of a Northern miniaturist, an offshoot of the de Limbourgs, magnified into a wall decoration. Here are the country occupations, the hunting and fishing, the declarations of love, the alfresco meals—all set in a ravishing landscape of flowers and little trees. Nowhere else, perhaps, do we find so much confirmation for William Morris's view of the Middle Ages as an earthly paradise.

So truly international is the style of these frescoes that we cannot tell whether the painter was French, German or Italian. Trent is on the pass that leads to Verona, and it was through Verona that the main current of Gothicism swirled into Italy. Of this Gothic influx Stefano of Verona is the complete exponent. His rhythms are the most melting, his Paradise garden the most flowery and fanciful of the whole movement. Incidentally, the curious style of his garden in the Verona gallery, with its isolated plants like a flowered textile, is clearly derived from another school of Persian illumination, of which a manuscript by the master Djunaid Sultani in the British Museum, dated 1396, is an example.

But the great master of North Italian Gothicism was Pisanello. Pisanello, by himself, is of course a subject for a whole course of lectures; to-day I shall deal with him simply as the chief exponent of the style which I have just been describing.

He was born in 1397, probably in Verona, and his earliest surviving work is very similar in style to Stefano's. The Virgin is in the enclosed garden, no longer the Queen of Heaven enthroned, but seated on the ground amongst the flowers and animals, and her drapery falls in a languishing sweep, although already the rhythm is rather larger than in Northern painting. At her feet is a quail painted with the concentrated attention to detail of a Gothic miniaturist. This Northern fashion for the realistic drawings of birds and animals had been introduced into Northern Italy before his time, as we know from such sources as the sketch-book of Giovanino de' Grassi, dateable before 1400, but Pisanello carried it to a point which has never been surpassed. His drawings combine the curiosity of science with the decorative finality of heraldry. In his drawings of hunting animals—leopards, horses, falcons, we see the connection between heraldry, chivalry and the chase. But his animals are also drawn with love, and it is symbolical that Pisanello should have combined his studies in a picture of St. Eustace which shows how, in the dark wood of medieval Nature, the animals may be under divine protection.

The work in which Pisanello comes closest to the miniaturists of the French Courts is the St. Anthony and St. George in the National Gallery. It is, alas, completely repainted—I tremble to think of the outcry there would be if it were to be conscientiously cleaned—but one must suppose that in essentials it was originally more or less the same—the Virgin, the superbly elegant St. George, the fringe of trees, are clearly imitated from one of the Duke of Berry's manuscripts. Only the St. Anthony, by his largeness of design, shows the Italian tradition. It is by this largeness, this sense of architectural and geometric form, that Pisanello's mature work is distinguished from the international Gothic. If we compare the head of Pisanello's princess from the fresco in St. Anastasia with the Burgundian portrait we have just seen, the innate monumentality of Italian art is evident. The rhythms of the Gothic portrait look thin and wayward beside the weight and drive of these splendid arcs. Yet it was from pictures of this kind that Pisanello derived the style which made him the first great Italian portraitist. The profile pose, the heraldic quality, the decorative use of the dress, most probably the flowers in the background, all come from Burgundian originals, of which only a few now survive. I need hardly remind you of Pisanello's miraculous transference of the Gothic miniature portrait to the medal, one of the most consummtae feats of skill in the history of art.

Pisanello was the most famous Italian artist of his day. He was continuously in demand at every court and in almost every important town in Italy. No artist before Michelangelo received such a volume of contemporary praise. In this his only rival was Gentile da Fabriano, who like him was constantly travelling from one commission to another. They were artists without a state, chiefly employed in cosmopolitan centres like Venice, Rome and Mantua. I emphasise this contemporary renown because in the eyes of posterity they have seemed much smaller figures than the great Florentines of the same epoch. This is partly because many of their works have been destroyed—the mortality of paintings in Rome and Venice was, for different reasons, very high, and partly because the aims and characters of the Florentines have been made vivid to us by Vasari. But there is another, more pertinent reason: they were fashionable artists. For thirty years international Gothic

was the style of the *beau monde*, as irresistible as the latest hat, with which in fact it was so closely connected. Whereas the style of Masaccio and Donatello, the artists of the humanist bourgeoisie, was independent of hats.

The spread of the fashion throughout Italy was largely due to Gentile da Fabriano. Gentile was at least twenty years older than Pisanello and was born in central Italy, well away from northern influences. Unlike Pisanello, he was not, so to say, a full member of the international Gothic party, and how he acquired the elements of that style is mysterious. This early work has the unmistakable rhythmic flow of the *dolce stil nuovo;* but already he has given it an Italian character. We should never be in any doubt as to the country of origin of this Madonna in the National Gallery of America, although the reasons for our certainty are not easy to analyse. This is the type of Gentile which influenced all the provincial painters of Italy—the Arcangelo di Cola's, the Salimbeni's, the Giambono's. But the real interest of Gentile lies in the influence he had in Tuscany, and in fact in the stronghold of intellectual art, Florence itself. To understand what this means we must recognise the extent to which the intellectualist style still dominated Florentine at the beginning of the fifteenth century, albeit in a desiccated and schematised manner. In the mid fourteenth century Florence had yielded to the influence of a more decorative style from Siena, and towards the end of the century the extravagant rhythms of Lorenzo Monaco had given it fresh vitality. By 1420 there was, indeed, one Florentine painter of the first rank, Fra Angelico, but his saintly art, passive and self-contained could not direct the artistic currents of the time.

It was at this point that two new forces appeared: the new intellectual humanism of Masaccio, and the intellectual Gothic of Gentile. On the one side were the frescoes of the Carmine, with their grave, massive figures, heroic in their intellectual energy and moral conviction, simplified with the architectural concentration of Giotto. On the other, these aristocratic figures, elegant, dreamy and coming from a dream, with their hawks, and monkeys and hunting dogs, and their golden brocades. Gentile's Adoration was painted for the sacristy of Sta. Trinita in 1423, and caused an immense sensation. Everything about it seemed to come from another world, even the decoration of the frame with flowers, which clearly derives from Flemish manuscripts, and influenced Ghiberti in the borders of his second doors. Two years later Gentile executed another commission in Florence, an altar piece for the Quaratesi family, of which the central part is now in the Royal Collection. These two pictures were the basis of his influence in Florence. Now it is evident to us, and it was evident to the Florentine artists at the time, that Masaccio's frescoes are the deeper form of art. But it is a form of art so deep that few painters, and fewer patrons could keep up in it for long. In spite of Masaccio's immense prestige they were continually sliding back into the graceful golden shallows of international Gothic.

The most obvious instance is Masolino. His early Madonnas have all the grace and tenderness of Gentile. Even as late as 1423 he was painting in this style. But two years later, under the influence of Masaccio, he painted the frescoes in the Carmine in such a remarkable simulacrum of the humanist style that insensitive critics have believed them to be by Masaccio himself. Finally in 1435 he returns to his true bent, and paints at Castiglion d'Olona the frescoes which are the most

enchanting reconciliation of international Gothic in type and gesture with the tradition of Italian wall painting.

Take two more instances. Domenico Veneziano, who took great pains to be employed in Florence, managed to assimilate the humanist style. Yet in the middle of his career he was able to paint a picture like the tondo of the Adoration, formerly in Berlin, which is so full of international Gothic character that until quite recently it was called Pisanello. Even more extraordinary, Uccello, who has gone down to history as the most passionate student of the new pictorial science, was able in his old age to paint the Hunt in the Wood at Oxford, which in spirit, in the rhythms of these elegant figures and their heraldic dogs, and in the dark wooded landscape, is a masterpiece of international Gothic.

But apart from these individual instances, Gentile's style produced a general revolution in the character of Florentine art. Fourteenth-century Florence, as we can still see from her architecture, was grim and austere. It was through Gentile's Gothic that the Florentines discovered their genius for grace and sweetness. It is from his time that flowers abound, that Our Lady is placed in an arbour of roses, or that the Holy Infants meet and embrace one another in flowery woods. In the *predella* of Gentile's Adoration is a sunny landscape, the first, I suppose, to appear in Florence. From that time forward Florentine artists turned their attention to landscape and even to effects of light. We are so used to reading of the *scientific* naturalism in Florentine art that we do not consider how much of nature in quattrocento painting came not from science but from love, from that sensuous delight in living things which was a development of late Gothic mysticism, and not at all of humanist rationalism.

This is not only true of the details of nature, but of the total impression, including that sense of space which is supposed to be the impregnable stronghold of Florentine science. Ten years before, Brunelleschi had taught Masaccio perspective, Hubert van Eyck, in the Turin Hours, had created effects of space which were hardly equalled again till the seventeenth century, and these effects he had apprehended through his eyes, and not through the elaborate geometry of the Florentine theorists. (Let me add in parenthesis that the reasons why I think that Hubert van Eyck existed and worked on the Turin Hours before 1417 would, if correctly stated, occupy another hour.)

International Gothic reached Florence as an aristocratic style; it became the popular style. This is not surprising, because all its ingredients—birds, animals, rich textures, fairy-tale princes and so forth—are eternally popular, whereas geometry is of passionate interest only to a few. It was therefore by borrowings from Gentile and the Burgundian miniaturists that the minor and decorative arts of the time took on much of that style which we consider characteristically "quattrocento." An obvious example is to be found in the *Cassone*, the painted wedding chests, on which, for half a century, you may find the prettiest hats in history, hats which gradually change their fashion from pure mediaeval to fantasticated classical; or the painted trays for birthday sweetmeats, where, as in the example before you, the garden, the trees and the Fountain of the *Hortus Conclusus* are all used as motives in popular iconography. The study of Majolica would yield the same results. But I will mention only one other popular art, that of engraving. Here

is one of the exquisite ladies of the *Très Riches Heures* about fifty years later, when in fact her hat had been long out of fashion, vulgarised for general circulation. The subject by the way, the Unicorn subdued by a Virgin, which will be familiar to you from the French Tapestries, is typical of the international Gothic attitude to Nature.

We saw that the international Gothic style really originates in Simone Martini. It is in Siena, too, that its beauties are for the last time perceptible. Those two enchanting artists, Giovanni di Paolo and Sassetta, although far more conscious of the Renaissance than is generally supposed, derive many of their graces from the North. Early in his career, Giovanni di Paolo painted a picture, now in Boston, of the Virgin and Child seated in a flowery clearing in the wood which is an epitome of the subject. Even his famous John the Baptist series shows remarkable correspondences with the Broederlam of almost sixty years earlier, from the whole composition with its fanciful architecture, which plays with space, and the rocky landscape, to details like the dandies in the scene of Salome's triumph. The late Anunciation and Expulsion in the National Gallery, Washington, painted about 1475, must be almost the last purely international Gothic picture.

But it was Sassetta, in his series of the life of St. Anthony Abbot, who used with most effect the discoveries of the Northern miniaturists, and, above all, their emotive landscapes. Sometimes these are clearly taken from a source like the *Très Riches Heures*, as in the beautiful scene where St. Anthony embraces his fellow hermit, St. Paul. The convex horizon of trees even has still visible the vestiges of a Burgundian castle. In other pictures of the series Sassetta's poetic sense of landscape carries him further than de Limbourg or any of the Gothic illuminators in the use of light to heighten our emotions. Only the unknown master who illuminated the *Livre des Cœurs d'Amour Epris* has achieved such a free expression.

I began by saying that the lack of any Gothic feeling in Giotto prevented him from being the ideal interpreter of St. Francis. I will end by showing two examples of Sassetta's St. Francis series in which the influence of international Gothic has given just that element of fantasy, ecstasy and love of creation which the subject required. By this time, of course, the nature of his subject had changed. To Giotto St. Francis was almost a contemporary. To Sassetta he was a legend, a fairy tale. Still, what could be more true to the Franciscan spirit than the famous picture of the Marriage with Poverty. Sassetta has taken the forms and rhythms of the Limbourgs, but has shed all the finery, the rich brocades of court painting. From him we see all that was really durable in the style—its grace, its gentleness, its power of investing Nature with spirituality. Thus international Gothic took what was most precious in the later Middle Ages and handed it on to the Renaissance.

Proposing a vote of thanks to the lecturer, the CHAIRMAN said: If the purpose of a lecture is to stimulate thought I think Sir Kenneth has very adequately fulfilled that purpose. His lecture has been full of hints and suggestions, which ought each to be expanded into a lecture on their own.

The vote of thanks was carried with acclamation and the meeting then terminated.



FIG. 1.—*Simone Martini.* ? 1285–1344.
Panel of Diptych.
Antwerp, Musée des Beaux Arts.



FIG. 5.—*Antonio Pisanello.* 1397,1399–1455.
SS. Anthony and George.
National Gallery, London.



FIG. 6.—*Giovanni di Paolo.* ? 1403–1482.
S. John the Baptist entering the Desert.
Chicago, Art Institute.

SOCIAL WELFARE IN THE WEST INDIES

By T. S. SIMEY, M.A.

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NEIL MATHESON McWHARRIE MEMORIAL LECTURE

Dominions and Colonies Section, Tuesday, April 15th, 1947

Sir HUBERT YOUNG, K.C.M.G., D.S.O., *in the Chair*

THE CHAIRMAN opened the meeting by introducing the lecturer, Professor Simey, who was recently the Welfare Adviser to Sir Frank Stockdale in the West Indies.

PROFESSOR SIMEY then read the following lecture:

The attention that is now being paid to the problems of the West Indies may seem at first sight to be somewhat excessive, having regard to the relatively small populations of this group of Colonies. It is justified, however, by reason of the fact that the group includes a number of Colonies which may be said to be in a "transitional" state in so far as they stand between the extremes of "advanced" and "primitive", being nearer the former than the latter. They thus represent those peoples who have progressed through the establishment of law and order, communications, and rudimentary social services, to a measure of social equality with the peoples of the Western world, and are anxious to translate this social equality into terms of political equality as well. It is the fact that the peoples of the West Indies are now reaching this stage which makes the investigation of their problems particularly important, for it is in the strategy of political advancement whereby the transition between "primitive" and "advanced" status can be promoted without undue dislocation and conflict that the British Empire has fewest discoveries to record. The process certainly takes place, but it is by no means a painless one, and it is not without grave dangers.

Lord Hailey has summed up the problem by saying:—

> "It is significant that a sentiment of alienation or estrangement has seldom shown itself in the early days of British administration. It is indeed characteristic of the British administrator that he has usually felt himself at his best and has had his greatest success in dealing with peoples at their more primitive stage . . . (This sentiment of alienation) is in truth, a natural outcome of an increasing sense of racial self-respect; and it is equally natural—though it may appear at first sight paradoxical—that it should become most patent where the tradition of the dominant community is, like that of the British—one of liberal institutions and a free press."

The same views have been expressed by other authorities.

It is now becoming more and more clearly apparent that the future of the Colonial Empire will depend on the possibility of evolving a workable strategy of this kind, which will bring into line the principles underlying the policy of our Governments, as expressed from time to time by Cabinet Ministers, with the expedients adopted by administrators to overcome the difficulties presented by the daily round of official business. It is with this in view that one should address oneself to the task of review-

ing the causes of West Indian discontents, and assessing the possibilities for their removal.

To speak about "social welfare" implies, of course, a definition of the phrase, and, if the foregoing observations are to be made relevant to the subject of this paper, it will have to be a broad one. As a matter of fact, however, this has always been the case so far as the social welfare services developed in recent years in the West Indies have been concerned. The subject of social welfare thus conceived does not amount to a mere catalogue of odd jobs, important as each one of them may be. It is not concerned merely with the delinquent child, the lonely aged person, the unemployed man, or the deserted wife. It is not constructed out of an assemblage of "problems", such as the status of women in the modern community, the decline in the strength of family ties, illegitimacy, the falling birth rate, overcrowding, promiscuity, and the like. There is undoubtedly a tendency in Great Britain, which is notable at times in Whitehall, to think of it thus, and this is leading many people down blind alleys of endeavour, and preventing a concerted attack on the many problems akin to those which have just been mentioned. The social welfare officer or social worker is, it must be emphasised, an important person with an important task in the modern world. He (or she) should be regarded not merely as a person who occupies herself by doing unwanted good works to the grateful poor, but as a social engineer. This conception is apparent in the statement of "primary aims" of social welfare services which was hammered out with West Indian social welfare officers in 1944. These were said to be:—

(1) The provision of services designed to enable rural populations to obtain the essentials of life—food, clothing, and shelter—in more adequate quantity;
(2) The development of social life enabling the isolation of the individual to be broken down;
(3) The encouragement of local leadership, local institutions, and the spirit of self-reliance, and the awakening in the mind of the individual of a knowledge that he possesses a measure of control over his own circumstances; and, to implement these,
(4) The appointment of a welfare staff prepared to practise what they preach by blending their lives with those of the people they serve, working *through* them rather than *for* them.

It will readily be appreciated that this statement implies a very definite philosophy of life, and an outlook on the problems of the modern world, while it is essentially part and parcel of the democratic faith which animates our nation. The only degree of strangeness in it for a British audience arises in the form of words which it was necessary to adopt to make it suit West Indian conditions. No more need therefore be said about fundamental principles; more interest will probably be found to lie in the technique of social administration based on them.

In order to provide the setting in which this technique has been developed, a brief account must be given of the arguments centring round the social problems of the West Indies. It is common ground that the West Indian peoples are poor, abjectly poor in fact. It is also common ground that social and political troubles are closely associated with poverty. But here the argument diverges between two schools of thought, for one would say that the poverty is the cause of all the troubles, whilst the

other would say that poverty and the troubles alike are the outcome of a single process of cause and effect. The former point of view is widely prevalent in the West Indies, and it is concluded that if poverty were removed the social millenium would follow; it is often naively assumed that this could be done merely by controlling what is termed "exploitation by the foreign capitalist or firm". When the economic problem is discussed intensively, however, what may be loosely termed the social problem immediately intrudes, thus demonstrating that the problem of poverty is actually part of a much larger complex of problems. For instance, poverty in the West Indies is sometimes attributed to poverty of natural resources, aggravated by an enervating climate which diminishes the incentive to work. Few would advance this argument, which is an exceedingly pessimistic one, in its simplest form, because if man's behaviour is determined by the climate, then there is very little (or perhaps nothing) that can be done about it. In fact, the argument is usually coupled with a qualification that economic incentives can be generated by an educational system if this is specifically so planned; education is thus relied on to re-shape the social structure. The main difference between economists at the present day thus appears to lie in the extent to which they consider this a possibility in the immediate future.

This is a vitally important point. It is pleasing to note that economists are now, unlike their immediate predecessors, tending to take into account the fact that their subject concerns the behaviour of human beings, and admit that this behaviour can be stimulated in a variety of ways, and not solely by a desire to consume that is—or is not—inborn! But it may be doubted whether this argument takes us very far in the long run, for if the educational system were to be made a social force powerful enough to re-shape the West Indian personality, so much money and effort would be absorbed in the process as to make any hope of political advance in the West Indies impossible for many years to come. It might well prove that shortages of natural resources would prevent the quasi-automatic development of an economic machine in this way, the result being a failure to produce the money and goods necessary to keep the governmental services going. In which case West Indians might well feel that they had sold their birthright for a mess of colleges.

What, then, is to be done if the problems of the West Indies are to be overcome? Is there any alternative interpretation of the process of cause and effect underlying the social problems of the present day which offers a greater measure of hope for the future?

Before this can be discussed, we must be clearer about the objectives to be kept in view in these endeavours. We must, for instance, assume in the first place that the goal we all have in mind is the construction of a West Indian way of life, of which the average West Indian can be proud, and which will allow the development of a common citizenship between the West Indies and what is usually referred to as the Western world. This will require many fundamental changes in the West Indian patterns of social life which prevail to-day. For instance, such evidence as there is goes to show that in the majority of cases the relationships between the sexes which lead to the procreation of children are of a temporary order, and that the institution of marriage (let alone the Christian form of family life) is a very unstable one. Enquiries conducted in Jamaica have shown that the two relatively stable forms which the family assumes there, the "Christian" family, and "faithful concubinage"

account for almost precisely half the total number of families in rural areas. The others are represented by what has been termed the "companionate" family, in which the association between the man and woman is merely transitory, and the "disintegrate" family, in which the man is in no sense a member of the family group at all. The consequences for the upbringing of the young and for society in general are as deplorable as they are obvious. They have been put thus, briefly and pointedly: "no families, no village life; no village life, no national life", and that represents perhaps the most difficult aspect of West Indian problems to-day.

How, then, can we introduce a new dynamic element into West Indian social life which will ultimately lead to the re-shaping of the life of the individual both in its more intimate patterns and in the more obvious or external forms of social, political, and economic activity? The first thing must obviously be to establish a new and firm scale of personal and social values, which will give the ordinary man something possible of achievement, and worthy of emulation, rather than the impossible standards of living set by those who have surrendered to the materialism prevalent in Harlem as in New York. Equally beyond the bounds of possibility are the ways of living made fashionable by weekly illustrated papers and cinema films, two of the most powerful educational forces, properly so called, being brought to bear on the West Indies. In addition to these outside influences, the middle classes suffer from a desperate need to demonstrate by the "Western" pattern of their own lives their equality with the middle classes in other parts of the world, and their separateness from the masses of their own countries.

Such a new scale of values can most easily be illustrated in terms of methods of building construction. So far as the rural peasantry is concerned, in places like Jamaica and Trinidad where local materials are at hand, new methods need to be evolved, or old ones revived, so as to make it possible for the man to build his own house without relying on imported commodities which are both expensive and unsuited to climate and landscape. The social prestige which at present attaches to the frame house constructed out of imported softwoods and roofed with corrugated iron is regrettable from both the economic and the strictly social aspects; not only does it limit housing construction very severely, but it also implies that what is "local" is also "inferior", a conclusion which can only be damaging to the self-respect of the West Indian. The new scale of values must, in fact, run right through social life. It is, again, evident in contemporary art and literature, which are for the first time emphasising the beauties of local scenery and flora, and the bodily characteristics of the Negro race. This is an exceedingly important contribution to social welfare, because a society cannot be healthy which undervalues its natural surroundings, and despises its own physical self as "inferior". But it is important to note that the new scale of values can only be established by example, and a heavy burden rests on the shoulders of all those concerned with the well-being of the West Indian peoples, particularly the West Indian middle class people and British civil servants, to accept these values themselves in their own lives, and thus lead the masses to accept them too. It is encouraging to be able to record that a remarkable awakening has taken place in this respect amongst the middle classes in the West Indies in recent years.

The establishment of a specifically West Indian culture, in which the ordinary

man can "rest", and of which the West Indian peoples can be legitimately proud, will do more than anything else to remove the causes of the conflict which undermines the effectiveness of the West Indian citizen. But this is obviously insufficient of itself. The conflict is due to the feelings of inferiority imposed on the West Indian by virtue of his colour; he is frustrated by the very nature of his being; he is anxious because of the insecurity of the inferior place which he occupies in the modern world. Both these conditions lead to the same unfortunate result, that the West Indian appears to the outsider to be either an aggressive or a somewhat remote or "touchy" sort of person, who is difficult to deal with, emotionally unstable, and unpredictable in his ways. The popular account of the West Indian is, indeed, somewhat contradictory, for it is equally true to say, and it is as generally recognised, that the West Indian responds very readily to affection, so long as it is sincere, and not tainted with patronage in any form. The fact that the West Indies is a place in which it is easy to make friends is well known.

The psychological processes underlying these outward appearances are now fairly clearly understood; they are very material to the subject-matter of the present paper because the troubles of the West Indies only lend themselves to diagnosis and treatment if they are studied from the angle of social psychology. The application of the old methods of goodwill and hard work can only lead to much the same results that they have always achieved; something new is needed in the technique of colonial administration if a way ahead through our present difficulties is to be found. One of my critics has, for instance, joined issue with me on this, and expressed the view that jargon of this kind merely obscures the issue, suggesting that one should speak of bad temper and selfishness rather than frustration, and maladjustment, and so on. But it may be replied that to speak of West Indians thus when one is attempting to find a solution for their troubles is merely rude. It leads nowhere. An attempt to discover the causes of the frustration the West Indian people undoubtedly feel is surely useful, because the sharing of their point of view helps one to understand their feelings as well as their thoughts. If in this connection it is true to say that to understand all is to forgive all, then an attempt of this kind is well worth the making by all those troubled officials and politicians who suffer the slings and arrows of outraged public opinion (as well as much private and personal abuse) day by day in the West Indies. It is also well worth the making by the West Indian statesman who would profit by an understanding of the feelings of frustration suffered by civil servants!

Contemporary sociology is much concerned with an attempt to translate the technique of psychotherapy from the consulting room of the analyst to the street and workshops outside. Many valuable results have been achieved in this way, particularly by that remarkable group of scientists who played so important a part in recent years in the affairs of the War Office. It is surely time to extend to the colonies the new technique which they and others have pioneered and the new attitude to the problems of human relationships which has accompanied it. We get from it, in the first place, what may be termed an amoral attitude to human problems, an ability to listen to a story of complaint objectively, taking the grievance that is expressed as a fact in itself, which demonstrates an attitude of mind requiring explanation, and perhaps calling for therapy. Our first object must be to collect

evidence, expressing neither sympathy nor a moral judgment. It must be emphasised time and time over again that it is only by the study of attitudes as things in themselves that we can arm ourselves with the means of controlling otherwise uncontrollable emotions. Having done so, the time has come when we can safely sympathise and justly express moral judgments. For example, the denunciation of the evils of promiscuity in the West Indies has never led anywhere. It must be realised that the pattern of social conduct we refer to by this opprobrious name is the result of certain predisposing causes, partly physical, partly social or psychological; in part it is attributable to economic insecurity and in part to the reactions which a man placed in a position of social inferiority is prone to suffer in greater or less degree. To blame a whole people for conduct of this kind is downright unfair; more important than this, however, it must exacerbate the problem by intensifying the very feelings of anxiety which lie at its root. It is useless, if not dangerous. But it still continues.

Similar arguments could be used about other West Indian social problems, for example, the theft of growing crops, for which the remedy of the "man on the spot" has only too often been flogging. There is also the problem of political leadership, which for many years has been, and still is, the cause of so much trouble, but as little or no attention has been paid to it by persons able to use modern techniques of investigation we know correspondingly little about it.

The argument thus presented will perhaps be more clearly understood if a concrete example is presented in the field of what has been termed "social engineering". Even assuming that the foregoing argument is substantially correct, it may still be asked what *can* be done about the problem of social welfare in the West Indies? Can any practical policy or administrative technique be based on it which is not impossibly remote from everyday facts and practical problems as they present themselves day by day?

The social welfare schemes that have been put forward in the West Indies have had as their objective self-determination both by individuals and communities, and with this in view their administration has so far as possible been placed in the hands of the beneficiaries of the various services, or of representatives of the people and local welfare organisations. These organisations, and the workers employed by them, have been encouraged to work out their own typically West Indian solutions for the problems with which they are presented, and also to regard themselves as colleagues of social workers in Great Britain and the United States. Welfare problems, again, are not thought of as something apart from other problems of government, but as part and parcel of the affairs of everyday life. The welfare officer is, for instance, so much brought into contact with economic problems and economic organisation in the development of producers' and consumers' co-operative societies and peasant handcrafts, and in other ways, that if he is to be successful in his task he will have to be more than a little of a business man—or woman.

The organisation that has come nearest to meeting the needs that are manifest in the welfare field in the West Indies is Jamaica Welfare, Ltd., a non-profit making organisation of the "public utility" type that has grown up as the result of local wisdom and initiative. As its name implies, it is both a "business" organisation devoted to the increase of economic wealth, and a "social" institution in so far as it

concerns itself through the medium of adult education of all kinds with the right uses of wealth. Both its Board of Directors and its staff include West Indians and citizens of Great Britain working together towards a common goal. That, more than anything else, can be expected to reduce the friction which has arisen from the consciousness of a man's colour and all the social barriers based on it. By tackling the problems of housing construction, of thrift, of recreation and of household management in all its forms, including nutrition, it is performing an educational task of no small magnitude. Its services are, it is important to note, carried on in the local vernacular, both actual and metaphorical.

Above all, it has learnt the lesson which the social worker in Great Britain has known for some little time—"You can't preach to a man with an empty stomach". Jamaica Welfare has found itself unable to tackle the problem of poverty by the indirect means of relying on education to awaken incentives, for this has been found to be not so much a long-term policy which is difficult to administer as a practical impossibility, something which simply fails to achieve any results at all. Direct responsibility for economic planning has therefore been assumed in a small way, for the most part in the field of peasant handcrafts. Similar conclusions and policies have been arrived at elsewhere in the West Indies, for the work of other welfare organisations and departments has been built up in close association with the work as carried on in Jamaica, and the original pioneering work carried out there may be said to have been made to a large extent the foundation of all welfare services throughout the Caribbean.

Many useful lessons have been learnt in this way, but most of them have been restricted to the level of the rural peasantry. The urban populations and the landless countryman have hardly been touched at all. Even so far as the peasantry are concerned, it is becoming obvious that the introduction of new forms of economic enterprise, such as the growing and the processing of the tomato, or the making of small articles of everyday use from fibres and straw plait is not sufficient to bridge the gulf between poverty and a reasonably secure standard of living. Economic security in the twentieth century cannot be based on peasant handcrafts. And, without it, the building of sound community life and healthy family life, and all that that implies, will be impossible in the long run.

The conclusion must, therefore, be boldly faced that minor tinkering with the apparatus of government, and with the economic machine, can be of little use in the long run. If what are substantially the old methods are still relied on, the results will still be substantially the same. We can see fairly clearly how new lines of advance can be developed in the social sphere, how, for instance, a direct attack could be developed on the problem of colour. But this will be of little avail if the problem of the standard of living is neglected. To deal with this effectively will require the sense of urgency, the technical competence, and the energy on which depended the success of the Mulberry Harbours. It is perhaps cruel to demand all this from the British people at the present time, but it is impossible to avoid it. There is only this to be said as a source of comfort for those who feel that the task is difficult to the point of absurdity. The economic argument, important as it is, can be pushed too far. While it is true to say that the problem of the rural—let alone the urban—proletariat cannot be solved by the production of peasant pottery and straw hats, it is still true that a

scheme which is not entirely comprehensive from the statistical point of view might yet have so important an effect on the social and political atmosphere of the West Indies as to be decisive in itself. The questions of the moment can be reduced to one central problem, that of confidence, which is the very cement which binds the fabric of society together. In former days, it was said that the West Indian got along well enough, basing his faith in a belief in the goodness of Queen Victoria. This simple faith was succeeded by a faith in the British Empire; this in turn is dissolving, and, it is asked, what is to replace it? In the long run, the only sound foundation for the life of the individual West Indian is a faith in himself *as* a West Indian, but the generation of this will be a long and difficult process. In the meantime the British people have a great deal to contribute to the situation. How is this contribution best to be made?

The problem of the re-establishment of confidence thus involves a re-casting of the links between the West Indian Colonies and Great Britain. In the vernacular of the twentieth century, this must be discussed in the first instance in terms of industry and employment, and the immediate task must, therefore, be to resolve what appears to be a deadlock in economic organisation. If even a single scheme of economic development could be inaugurated of such a kind and on a sufficiently large scale to show that a way ahead can be broken through the difficulties that have hitherto inhibited progress, the whole political situation in the West Indies would be transformed. A scheme of this kind would have to make provision for industrial development, for it is this, and this alone, which is sufficiently profitable to make any substantial difference to the standard of living in the West Indies. In another part of the Empire we have recently seen the inauguration of a gigantic scheme for the growing of ground nuts which, in the size and amplitude of its conception, rivals the ideas which underlie the Tennessee Valley Authority. British enterprise and British statesmanship are therefore still very much alive. It remains to be seen in what way a scheme for economic development suited to the conditions of the West Indies can be conceived.

It is obvious that the most promising line of advance is to take into consideration the economic needs of both Great Britain and the West Indies simultaneously in planning a scheme of this magnitude. If anything of significance to the problems, even of a single island such as Barbados, is to be achieved, the cost will have to be reckoned in terms of millions of pounds, far more than can ever be financed under an Act of Parliament that is restricted in its scope to *colonial* development and welfare. The overstrained resources of Great Britain will simply not allow so large a drain on the national revenues if nothing is to be brought in in return. But the technical needs of British industry give us a lead as to how such assistance can become reciprocal. The Lancashire textile industry, for instance, is desperately short of yarn; is it too fantastic a suggestion that a spinning industry could be started in, say, Barbados, where the supplies of labour are only too ample, and the ties with Great Britain are particularly close? There are, one can only feel confident, many firms and many individuals who would be only too eager to assist in the development of an enterprise of this kind, calculated to catch the imagination of all who study the needs of the West Indian people.

The question remains to be answered whether the resources of suitably trained

and experienced man-power and of wealth available to us at the present time are sufficient to enable us to undertake the development of the West Indies in the way that appears to be necessary. But the magnitude of the issues at stake justifies a similar magnitude in the effort which we must make to justify the continuance of the ties which link the various territories of the Empire together. Above all, we must demonstrate by some sort of constructive endeavour, rather than by piecemeal patching, that the British people deserve to continue to occupy the central position in our system of imperial relations. Faith in the British people is the only justification for the proposals which have been put forward. Their achievements during the war have shown that there are always people ready to answer any call that may be made on them; there is surely a pioneering spirit and a bond of mutual confidence still present amongst us of ample strength to supply the foundation on which our Empire can be built anew, according to the ideals so nobly stated by our representatives during the dark years of defeat.

DISCUSSION

Mr. C. W. W. GREENIDGE : I have heard recently that the average West Indian works only 2½ to 3 days a week, and therefore the standard of the West Indian cannot rise unless his output of work is considerably increased. The cause of this was said to be the climate, or possibly partly nutrition. I would like to ask whether the lecturer would agree with this statement.

THE LECTURER : First there is no average West Indian. There are many different sorts of people who are West Indians, some of whom are unsatisfactory employees.

As to the physiological argument, there are of course losses in energy in the tropics due to the difficulty of cooling the body, but how far this is the cause of irregular or unsatisfactory work remains to be proved. Much depends on the adopting of sensible habits of life and on the improvement of working conditions. Still more depends on the offering of the right incentives to work, and on the generation of new dynamic forces within the community which will supply the economic machine with motive power. I was told, when I went to the West Indies, that if I took a house and a West Indian domestic staff, my wife and I would suffer in body and in mind, because of the unreliability of West Indian servants. We took on two households of West Indian servants, entirely at random. After we had paid them properly, shown we trusted them, both of which are enormously important, and fed them decent meals, we had the two best domestic staffs my wife and I ever had anywhere.

Mr. S. MORRIS: I would like to ask the Lecturer whether in his opinion there is such a thing as West Indian culture.

THE LECTURER: I think West Indian culture is rapidly growing now. The West Indies Welfare Training Course in Jamaica is an example of a West Indian cultural institution in the development of which I played a part myself. The attitude of most people has been hitherto that anything "West Indian" was inferior, and ought to be suppressed. But a new outlook is now manifest in the West Indies. In Jamaica, Trinidad, and British Guiana, you find literature, painting, and folk music which have many affinities, constituting in many respects a basic folk art.

You will have probably seen the Exhibition of Jamaican Painting in London. The men who painted those pictures are simple everyday Jamaicans expressing their own ideas about the beauties of the West Indian scene.

Mr. F. SEAL COON: What is your explanation or reason for the overcrowding of the islands, which might bring all the social welfare institutions to an end?

THE LECTURER: Overcrowding is of course only a relative term. Over-population can only be said to exist when the pressure on the economic apparatus of the community is excessive. Barbados is obviously over-populated, because they are trying to support an urban area on an agricultural industry. The answer to it, as far as

Barbados is concerned, is industrialisation. The industrious hardworking Barbadian would do well in industry if given a chance.

The other problem is that of the differential between the birth and the death rate. The birth rates in the West Indies will remain high for many years to come, until the patterns of social relationships become more similar to those of Western society. It is no use trying to adopt short cuts, or a big State-aided birth-control process in the West Indies. It would not work. It will, however, be surprising to the sociologist if the various patterns of Western society which go with industrialisation do not also bring a lowering of the birth rate.

Mr. S. MORRIS: What is the cause of the looseness of family relationships in the West Indies, when in Africa, where the root of the bulk of the population of the West Indies lies, the pattern of family life is not as disintegrated as it is in the West Indies. Can you suggest the cause which produces this, and if so, how do you propose to get at the root of the cause?

THE LECTURER: This is one of the spheres in which academic fury burns brightest. The dispute centres round the question whether the social institutions of the Negro peoples of the New World can be said to be "African" or "Western". Professor Herskovits says they are "African", Professor Franklin Frazier says they are "Western". I am on the side of the latter, though I can only profess to appear as a minor squire of Frazier's in this battle. Frazier's theory is that the casualness in the social relationships prevalent amongst the Negro peoples of the New World is attributable primarily to economic causes operating through the medium of the institution of slavery. The social relationships of Africa were dissolved on the slave estate, and were re-cast in a new world. For example, the fecundity of women was directly established in those communities by reason of the profitability of the high birth rate to the slave owner. The position of women in society was established by reason of the fact that a man was not allowed to protect a woman on a slave estate, because that interfered with the discipline of the estate. Relationships of that kind were ruthlessly crushed. I think Frazier's thesis is overwhelming in its cogency.

What is remarkable is that the impact went so far, and has receded back so far. The looseness of relationships on the sugar estates in the eighteenth century must have been almost complete, as is shown by Monk Lewis's diaries. In contemporary Jamaica it is something like fifty-fifty. That may look a pretty poor thing, but viewed historically it is remarkable that the looseness has receded even as far as this. The social institutions of the middle classes show that a firm social bond of an entirely new kind can be created if given favourable conditions. Human relationships in the West Indies, and in all the advancing communities, have been shown to possess an astoundingly high degree of plasticity. Therefore I am fundamentally optimistic: if once we can be clear about our goal, and united in our objectives to attain it, we should be able to do a tremendous amount inside our own generation to establish the kind of society in the West Indies which we all want to see.

Mr. J. C. FLORES: Surely the material wealth of the West Indies must be returnable to the West Indian in person, and unless help from the Colonial Welfare and Development Scheme can be supplied in a sufficiently ample amount, and the resources of the West Indies can be diverted to the West Indian, and until his own material welfare is raised, no large improvements can be expected in family relationships or in culture. Am I right in assuming that British Government officials can only give directives on this?

THE LECTURER: When I was in the West Indies, the trouble was that the banks were bursting with West Indian wealth which nobody knew what to do with. It lay around in millions of pounds. There was nothing to invest it in.

The trouble is, to my mind, that we have not done enough social engineering. We have said to the peoples of the West Indies, as we said to the peoples of the Colonial Empire all over the world—We shall establish law and order; but business men must do the pioneering work of creating wealth. The West Indian Government have burnt their

fingers so often that they are reluctant to touch business enterprises in the future. My gospel is the marrying of public and private enterprise in various proportions and various ways. Jamaica Welfare Limited is a good example of this sort of social engineering. The capital has come mainly from a levy on the banana industry, though grants under the Development and Welfare Act now support the organisation. The West Indian is not going to be doctrinaire about things, so long as he gets a chance to show what he can do.

THE CHAIRMAN : Professor Simey has recently published a most interesting book, *Welfare and Planning in the West Indies*, which I recommend you all to read.

What is needed is to give to the West Indian somehow a confidence in the future, and some goal which in his mind it is worth working towards. Given this all other difficulties will disappear.

After a vote of thanks to both the lecturer and the chairman had been carried with acclamation, the meeting terminated.

ERRATUM

We regret that Fig. 9 on page 699 of the issue for September 12th was inadvertently attributed to Adam Hilger, Ltd. The Society is in fact indebted to the Research Laboratories of Messrs. W. T. Henley's Telegraph Works Co., Ltd., for this illustration, and tenders its apologies to them for this error.

NOTES ON BOOKS

ENGLISH COUNTRY CRAFTS. By Norman Wymer. Batsford. 1946. 12*s.* 6*d.*

This is a heritage book: for there are few finer heritages than the artistry and fitness for purpose of our ancient English country crafts. Mr. Norman Wymer has summarised them exhaustively, from glass-blowing to gate-hurdle making, and from lace-making to lobster-pots. He deals with village and woodland crafts, the accessory crafts which serve the workers in greater industries (such as tanning or coopering), the cottage and home crafts, the water crafts (boat-making in especial), the rural industries of quarrying and china-clay digging, and the cultural crafts (such as pottery and cabinet-making) which satisfy man's æsthetic instincts and may perhaps prove the most enduring of them all. He shows how ancient are the crafts of man—flint knapping, for example, still carried on at Brandon on the borders of Norfolk and Suffolk (though only to make gun-flints for the natives of South Africa), is probably the oldest craft in the world—and how, in this country, they have thriven for the most part away from the towns, their skill often descending to generation after generation of the same family and providing a sturdy breed of honest workers who have laboured with their hands the things that are good. His account is delightfully illustrated by a wealth of modern photographs, and those reproductions of early prints and woodcuts and engravings which one inevitably looks for with pleasurable anticipation in a Batsford Book—149 in all. The photographs of wheelwrighting are particularly attractive, as are the dainty engravings of charcoal-burning, weaving, hop-picking, and so forth, from Pyne's *Microcosm* and *Costume of Great Britain*.

As a historical survey of this wide subject Mr. Wymer's book is entirely admirable. But it does propound a tremendous problem for the future. How much of all this is to survive? How, for example, can the wheeled farm-cart ever again take the place of the tractor, or the well-made saddle find a ready sale in a world which uses the horse merely for riding to hounds or for "putting your money on"? (How much has, alas! already degenerated into feeble "arty-crafty"ness—though on this degeneration Mr. Wymer wisely does not touch?) What place is there in fact in a complex modern world which moves at an ever-increasing *tempo* for the hand-made as opposed to the mass-produced article? And one must remember in all fairness that the mass-produced article has made for more decent living, and, even in some respects, more gracious living, for millions of

the population whose lives in the "good old days" were little better than that of Hobbes's unsocial man—"poor, nasty, brutish, and short". This issue the author faces squarely. "That the country craftsman will regain *all* his lost glory there is no hope", he says. Though for the adjustment of many still useful old crafts to contemporary needs there does exist the Rural Industries Bureau, which surveys the different county industries and informs the workers of changes and opportunities, guiding them in their problems. "If craftsmanship is to survive", Mr. Wymer asserts, "it must do so, not on the grounds of mere beauty or tradition, but on account of its continued usefulness to twentieth-century life".

And two solutions thus emerge. The crafts that can and should survive are (as has been said with regard to the cultural crafts) those which add to the grace and beauty of life, and which provide that vision without which a people perish, however cheaply and efficiently and hygienically they may be served by mass-production. But still more must the best of the ancient crafts survive as the coming generation, in its hours of increased leisure, re-learns the old lesson of working with its own hands instead of other people's, and finds the best escapism (to use a sadly over-worked word) from the hurry and standardisation of modern life in the sheer joy of creation. For, if to travel hopefully is better than to arrive, to make is essentially better than to use. And herein lies the greatest value of Mr. Wymer's fascinating book: its constant insistence on the delight of doing things for oneself. If *English Country Crafts* teaches its readers something of that joy of working with the hands it will have laid down an abiding creed. For all the craftsmen of whom its author tells, whether they wrought in wood or wool or stone or metal, dealt with their materials as good Izaak Walton laid down long ago that the fisherman should deal with his frog—"handle him as though you loved him". That is the true test of the joy of creative craftsmanship; and even in a world of super-cinemas, of cup finals and of dog-tracks, that will, in the long run, prove most satisfying to the soul.

NORAH RICHARDSON.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, OCTOBER 13..Electronics, Institution of, at the Royal Society of Arts, W.C.2. 6.30 p.m. G. F. J. Garlick. **"Luminescent Materials and Infra-Red Radiations"**

TUESDAY, OCTOBER 14..Chemical Engineers, Institution of, in the Institution of Mechanical Engineers, S.W.1 5.30 p.m. Dr. R. V. Southwell. **"Relaxation Methods : A Mathematics for the Engineer."**

Electrical Engineers, Institution of, at the Engineer's Club, **Manchester.** 6 p.m. F. Widnall and R. Newlound. **"Protective Finishing of Electrical Equipment."**

WEDNESDAY, OCTOBER 15..Sanitary Institute, Royal, 90 Buckingham Palace Road, S.W.1. 2.30 p.m. F. L. Barrow. **"Some Features of American Plumbing and their application to this country."**

In the Town Hall, **Chester.** 10.45 a.m. (1) Arnold Brown **"The Administrative Aspects of the Care of Children."** (2) Charles Greenwood. **"The Replanning of an Ancient City."**

THURSDAY, OCTOBER 16..Fuel, Institute of, at Gas Industry House, S.W.1. 2.30 p.m. Major Kenneth Gordon, **"Hydrogenation in the Fuel and Chemical Industries."**

Textile Institute, Midland Hotel, **Bradford.** 7 p.m. L. H. C. Tippett, **"Quality Control in the Textile Industry."**

MONDAY, OCTOBER 20..Electrical Engineers, Institution of, at the Liverpool Royal Institution, **Liverpool.** 6.30 p.m. W. Fordham Cooper, **"Electrical Control of Dangerous Machinery and Processes."**

TUESDAY, OCTOBER 21..Electrical Engineers, Institution of, at the James Watt Memorial Institute, **Birmingham.** 6 p.m. D. B. Hoseason. **"The Practical Training of Professional Electrical Engineers."**

At Electricity Showrooms, **Derby.** 6.30 p.m. J. Hacking and J. D. Peattie. **"The British Grid System in War-Time."**

Engineers, Society of, at the Geological Society, W.1. 5.30 p.m. Dr. G. E. Blythe. **"Fine Grinding in Industry."**

International Affairs, Royal Institute of, 10 St. James's Square, S.W.1. 1.30 p.m. Lord Lindsay, **"Democracy and a Leisured Class."**

WEDNESDAY, OCTOBER 22..East India Association, at Over Seas House, S.W.1. 2.30 p.m. Sir Henry Twynam **"The Two Dominions and Treaty Relations."**

Electrical Engineers, Institution of, at the Engineer's Club, **Manchester** 6.30 p.m. D. Gabor, **"New Possibilities in Speech Transmission."**

THURSDAY, OCTOBER 23..Chemical Society, W.1. 7.30 p.m. Tilden Lecture. Professor E. G. Cox, **"Crystallographic Technique and its Chemical Significance."**

In the University College, **Hull.** 6 p.m. Professor H. Hey, **"Addition Polymerisation."**

Textile Institute, **Manchester.** 6.30 p.m. E. Lord, **"Some Practical Aspects of Sampling with Special Reference to the Cotton Industry."**

Town and Country Planning Association, 28 King Street, W.C.2. 1.15 p.m. Charles Madge, **"The Social Growth of a New Town."**

FRIDAY, OCTOBER 24..Chemical Society, at the University College, **Southampton.** Professor C. K. Ingold, **"Isotopes and Molecular Spectra."**

Sound Recording Association, British, at the Royal Society of Arts, W.C.2. 7 p.m. M. J. L. Pulling, **"Sound Recording as applied to Broadcasting."**

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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VISIT OF H.R.H. THE PRINCESS ELIZABETH

The number of applications for seats at the Inaugural Meeting has greatly exceeded the capacity of the Lecture Hall and it has been decided, in order that Fellows may not be disappointed, to arrange an overflow meeting in the Library, presided over by Sir Edward Crowe, K.C.M.G., to which the proceedings will be relayed. Holders of Library tickets will have an opportunity of meeting the Princess after the proceedings upstairs are concluded. In the Library there will also be a display of important early documents of the Society and of the articles bequeathed to the Society by Lord Bennett.

Tickets for the Lecture Hall have already been allotted in the order of receipt of applications and are being posted to Fellows. All remaining applicants up to the date of going to press will be allotted a ticket for the Library. There are still a few tickets available for the Library meeting for which immediate application is invited. Allotment of these remaining tickets, if necessary by ballot, will be made on Tuesday, 28th October.

It is still necessary to restrict the issue of tickets to one per Fellow. Fellows allotted a ticket who subsequently find themselves unable to attend are urgently requested to return it without delay to the Secretary.

Holders of tickets are requested to be in their places by 2.15 p.m. and seats cannot be guaranteed after that time. Lounge suits will be worn.

MEETING OF COUNCIL

A meeting of Council was held on Monday, October 13th, 1947. Present: Sir Harry Lindsay (in the Chair); Lord Aberconway; Professor E. N. da C. Andrade; Mr. F. H. Andrews; Mr. A. C. Bossom; Sir Frank H. Brown; Major W. H. Cadman; Professor E. C. Dodds; Sir Thomas Dunlop; Professor C. S. Gibson; Mr. E. W. Goodale; Dame Caroline Haslett; Dr. R. W. Holland; Sir Henry McMahon; Mr. J. A. Milne; Mr. F. A. Mercer; The Hon. Harold Nicolson; Sir Ernest Pooley; Mr. J. W. Ramsbottom; Mr. E. M. Rich; Mr. A. R. N. Roberts; Mr. E. Munro Runtz; Captain A. H. Ryley; Mr. William Will and Miss Anna Zinkeisen; with Mr. K. W. Luckhurst (Secretary) and Mr. C. J. Buchanan-Dunlop (Assistant Secretary).

The following candidates were duly elected Fellows of the Society (this is the first list to be issued since last July):—

Allistone, Alfred Barron Wilmot, London.
Allsebrook, Mrs. Mary Nesbit, Wargrave-on-Thames, Berks.
Allport, Kenneth George, Chessington, Surrey.
Amor, Donald Raymond Price, Cheltenham, Glos.
Archavsky, Lieutenant-Colonel Alexander I., London.

Auty, Clifford Marshall, B.Sc., Romford, Essex.
Baker, Reginald Poynton, Staplehurst, Kent.
Baker-Harber, James Algerin Charles, London.
Barnes, John, Birmingham.
Beling, Christopher Lorenz, Colombo, Ceylon.
Bell, Henry Charles, Birmingham.
Bentley, Thomas Everard Charles Reginald, London.
Bowen, John Herbert, O.B.E., Swanage, Dorset.
Bowen, Thomas Alfred Edwin, London.
Bowels, Harold Carter, Cheltenham, Glos.
Boyes, George Richardson, B.Sc., London.
Breeze, John Frederick, B.Sc., London.
Brown, John Antony Salkeld, Bury, Lancs.
Brend, Oliver Louis, Stoke-on-Trent, Staffs.
Bruce-Williams, Mrs. Leonora, Bournemouth, Hants.
Burfield, Edward L., London.
Calman, Montague, London.
Carter, Donald Frederick, Welwyn Garden City, Herts.
Cavalcanti, Alberto de Almeida, London.
Chapman, Mrs. Olive Murray, London.
Churchill, Miss Irene Josephine, D.PHIL., Shortlands, Kent.
Clarke, William Frank, Wembley Park, Middlesex.
Coleman, Ernest Charles, London.
Collingham, Robert Hugh, Rugby.
Dalrymple, James Blake, M.C., Ayr, Scotland.
Damon, William Aethelbert, C.B.E., B.Sc., London.
Davies, Maxwell Hawkins, London.
Dobie, William Bowe, M.Sc., Newcastle-upon-Tyne.
Dodd, Sir John Samuel, M.A., Windermere, Westmorland.
Dowd, William Joseph, B.A., Sydney, Australia.
Duckworth, Ferdinand Farrant, Hong Kong, China.
Eaton, Richard Victor, B.Sc., Caerwent, Monmouthshire.
Edwards, Wilson Molyneux, Romford, Essex.
Egon, N. R., London.
Elce, Norman, M.Sc., Altrincham, Cheshire.
Fellowes-Farrow, Edward Stanley, M.A., M.Sc., PH.D., London.
Finnigan, Brian William, B.A., Bowdon, Cheshire.
Flatow, Leon Stansfield, Kingston-upon-Thames.
Flemington, Colonel the Reverend William Thomas Ross, O.B.E., M.A., D.D., New Brunswick, Canada.
Fletcher, Charles Bradford Kyrle, Newport, Monmouthshire.
Fox, William, Gainsborough, Lincs.
Francis, Sydney, Bradford, Yorks.
French, Sir Henry Leon, G.B.E., K.C.B., London.
Garratt, Edmond Carlton, London.
Gilbert, Raymond Charles, M.A., Beckenham, Kent.
Gill, Percy James, M.A., Nairobi, Kenya.
Goddard, James Alan, Surbiton, Surrey.
Grant, Julius, M.Sc., PH.D., Cardiff, Glam.
Greenham, R. G. Harvey, B.A., LL.B., London.
Gregory, Arthur John, London.
Groves, Mrs. Pamela Joy, Esher, Surrey.
Halnan, Edward Thomas, M.A., Cambridge.
Hampton, John Winnall Franklin, M.A., Johannesburg, South Africa.
Harcourt, William Michael, Gerrards Cross, Bucks.

Harder, Kenneth Arthur, D.F.C., Watford, Herts.
Harrison, Geoffrey Arthur, M.D., Chelsfield, Kent.
Harrison, Hugh Wollen, Southsea, Hants.
Harrow, Professor Benjamin, New York, U.S.A.
Hartles, Ronald Lewis, B.Sc., Widnes, Lancs.
Hartley, Rex Bassett, East Horsley, Surrey.
Harvey, Arthur, Croydon, Surrey.
Harvey, Charles Christopher, London.
Haslam, George Stanley, B.Sc., PH.D., Doncaster.
Haslam, George Eric, B.A., Manchester.
Hay, Daniel, Whitehaven, Cumberland.
Hazelgrove, Albert James, Ottawa, Canada.
Hibberd, Leslie Frank, London.
Hickman-Smith, Arthur Ernest, London.
Hilton, Charles Lacy, Newport, Monmouthshire.
Hinchy, Victor Matthew, D.Sc., Durban, South Africa.
Hind, Harold Stanley, Cobham, Surrey.
Horne, Francis Morris Ambrose, London.
Hudson, Cyril Henry, Sanderstead, Surrey.
Ing, Harry Raymond, D.PHIL., Oxford.
Jackson, Albert, M.Sc., Manchester.
Jansen, Professor B. C. P., PH.D., Amsterdam, Holland.
Jeffrey, Lieutenant-Colonel James Patrick, T.D., B.Sc., Aberdeen.
Jessop, Denis, S. A. E., M.A., Harrow, Middlesex.
Jones, David Richard, Liverpool.
Julian, Francis William, Penzance, Cornwall.
Ker, Frederick Innes, C.B.E., B.Sc., Dundas, Canada.
King, Arthur Charles, London.
Knopp, Leslie, Croydon, Surrey.
Kuray, Vasant Damodar, London.
Labarthe, André, D.Sc., Paris, France.
Laett, Dr. Arnold, Zurich, Switzerland.
Lear, George Stanley, Carshalton, Surrey.
Leeson, Colonel Bruce Hamer, O.B.E., T.D., Sanderstead, Surrey.
Leighton, Morris Morgan, B.A., M.Sc., PD.H., Illinois, U.S.A.
Line, Frederick Faulkner, London.
Lucas, Major Victor, London.
Lucking, Tom Scotson, M.A., Bedford.
Luker, Leslie Gordon, London.
McEwen, Dr. Marjorie Bruce, B.Sc., London.
McKenzie, Windsor Colin, Berkhamsted, Herts.
Mahadik, Khanderao Bhujangrao, B.A., Kolhapur, India.
Malowan, Professor Lawrence Sigfrid, PH.D., Panama City.
Mancini, Frederick, London.
Mann, Edward John, Hatfield, Herts.
Mann, Paul Bevington, Harrow, Middlesex.
Manning-Cocking, Kelvyn Tavistock, Melbourne, Australia.
Markham, George Robert, Ipswich, Suffolk.
Marsden, Frederick, Solihull, Warwicks.
Melling, Percy Butler, London.
Moncrieff, Professor Alan Aird, M.D., London.
Monkman, John Vivian, London.
Moore, James Thomas, B.Sc., Twickenham, Middlesex.
Neal, Lawrence Edward, London.
Nixon, Charles Basil, Lytham, Lancs.

Nuttall, Cecil, Betchworth, Surrey.
Owen, John Drummond, Marrickville West, Australia.
Parker, Albert, C.B.E., D.Sc., London.
Pedrozo, Commander Miguel Angel, London.
Peterson, George Reynolds, Saskatoon, Canada.
Pinkney, Renny Bourdas, Rickmansworth, Herts.
Pryke, Sir Dudley, Bt., London.
Ramos Enriquez, Professor Domingo, Habana, Cuba.
Read, Sidney, M.B.E., M.C., B.Sc., London.
Reynolds, Russell John, C.B.E., London.
Rowland, John Herbert Shelley, B.Sc., Radlett, Herts.
Saint, Reginald, London.
Sammons, Herbert, Gerrards Cross, Bucks.
Samuel, Eric., B.Sc., M.D., Johannesburg, South Africa.
Sangster, John Armstrong, Bromsgrove, Worcs.
Saunders, Professor Richard Lorraine de Chasteney Holbourne, M.D., Nova Scotia, Canada.
Sherwood, Robert Emmet, New York City, U.S.A.
Sikkim, H. H., the Maharaja of, K.C.S.I., K.C.I.E., Sikkim, India.
Sime, John Cecil Moncur, Woolton, Liverpool.
Slater, Ernest Stanley, Ashford, Middlesex.
Smith, Sir Alexander Rowland, Ightham, Kent.
Smithells, Colin James, M.C., D.Sc., Gerrards Cross, Bucks.
Spratt, Norman Witherington, Chalfont St. Giles, Bucks.
Stanfield, Miss Marion Willis, London.
Storey, William Henry, Croydon, Surrey.
Stratton, Francis John, M.A., London.
Sturgeon, Henry George, London.
Sugden, Professor Samuel, D.Sc., F.R.S., Epsom, Surrey.
Summers, Frank, Sutton, Surrey.
Swarbrick, Thomas, London.
Tickell, Major-General Sir Eustace F., K.B.E., C.B., M.C., Cobham, Surrey.
Tilden, Philip Armstrong, Lifton, Devon.
Titley, William Gerard, London.
Tomlinson, Carl Perkins, Montreal, Canada.
Townend, Donald Thomas Alfred, D.Sc., PH.D., London.
Toy, Francis Carter, D.Sc., Didsbury, Manchester.
Treleaven, Reginald Henry, London.
Turner, Arthur James, M.A., D.Sc., Lambeg, Co. Antrim.
Vickers, Antony, B.Sc., Isleworth, Middlesex.
Wagg, Kenneth Arthur, Slough, Bucks.
Wakeford, John Chrysostom Barnabas, Rangoon, Burma.
Welch, John George Embleton, Wolverhampton.
Welsh, Robert James, Rugby, Warwicks.
Willett, Basil Rupert, C.B.E., D.S.C., Chelmsford, Essex.
Winterbottom, Leslie Ernest, M.Sc., London.
Wood, Miss Narcisse Elise Matilda, London.
Woolcott, Wilfred Robert, Westcliffe-on-Sea, Essex.
Wray, William Herbert, Rotherham, Yorks.
Wyber, William Leonard, Auckland, New Zealand.

The following were duly elected Associates of the Society :

Brown, Phillip Motram, Basingstoke, Hants.
Haines, Miss Elizabeth Hillary, West Wickham, Kent.
Liddle, Noel Ivan, Enniskillen, Co. Fermanagh.
Shepperd, Roy Alfred, London.

Arrangements for the Inaugural Meeting were discussed, and the Programme of Lectures which had been arranged for the 194th Session was approved.

The report of the Craftsmanship Committee, appointed in July, was considered. It was decided that the only action to be taken on this matter at present, apart from the special series of lectures to be included in the Sessional Programme, should be to give the Society's full support to the already established Crafts Centre of Great Britain.

Mr. I. Purdam, A.S.A.A., was appointed to succeed Mr. A. G. Toye as Accountant on the latter's retirement at the end of the year.

A quantity of formal and financial business was transacted.

BEQUEST TO THE SOCIETY BY THE LATE PRESIDENT

The Society has now received the bequest which was made to it in the will of the late Viscount Bennett. This bequest comprised the following items :— A pecuniary legacy of two thousand and five hundred pounds; a bronze buffalo presented by the Canadian Legion of the British Empire Service League; a bronze Cowboy presented by the Calgary Kiwanies Club; a bronze tiger; bronze horses, by Desmet; bronze horses, "Au but", by P. Rigual; a silver replica of the Warwick Vase; an Adam chair; a table; some publications of the Champlain Society and a set of works of Elbert Hubbard, in twenty volumes. The chair and table were from Lord Bennett's own room and the latter had previously been in the possession of another Prime Minister, Benjamin Disraeli.

These various objects will be displayed at the Inaugural Meeting.

MODERN SURGERY AND THE APPLICATION OF RECENT PHYSICAL DISCOVERIES TO MEDICAL DIAGNOSIS AND TREATMENT

By A. Dickson Wright, M.S., M.B., F.R.C.S.

CANTOR LECTURES

Lecture I.—*Delivered 27th January*, 1947.

THE ADVANCES OF MODERN SURGERY

In the great increase in the expectation of life which we now enjoy, surgery has played a very great part, not to be compared with the great sanitary epidemic-preventing measures, but, nevertheless, a very considerable part. To take a concrete instance, appendicitis would probably account for 75,000 deaths a year in this country without the surgical operation which now saves 70,000 of these cases annually, or instead of the 50,000 deaths from cancer, without surgery there would be the appalling figure of 300,000.

Surgery since the middle ages has gradually raised itself from the ignominious position of a side-line of the hair-cutting business to a position second to none in the professions, and this has been accomplished by a steady improvement of the service it has offered to suffering humanity. In many diseases the situation is such that the patient has only one choice, surgery or death.

In early days surgery was confined to blood-letting and urgent operations for opening abscesses and removing septic and gangrenous limbs. In amputations great dexterity, speed and strength were shown by the surgeon and great fortitude by the conscious patient. Baron Larrey's amputations in the trail of Napoleon ran into thousands upon thousands, and his skill was perhaps as remarkable as the fanaticism of the soldier who tossed his amputated arm into the air with the cry of "Vive l'Empereur"! Perhaps more useful was the action of the British officer at Waterloo who, after losing his leg below the knee, straightway mounted his horse and galloped back to the battle to encourage his men to greater efforts by his brave example. The painful and all-demanding condition of stone also drove patients to surgery in the olden days, and great skill was shown by surgeons in cutting for this condition, especially at St. Thomas's Hospital where the diarist Samuel Pepys lost a stone the size of a tennis ball on March 26th, 1658. Ever grateful to his surgeon and ever a lover of junketing, this date became an annual celebration for Pepys and his friends for the remaining 40 healthy years of his life. At these celebrations the stone in its 24*s.* case was produced, and there was much talk of the suffering of the past and the joys of the present. The removal of a stone in those days was a great and perilous adventure, whereas to-day it is a safe and simple procedure.

Surgery down the ages made steady progress but, as in all sciences, there were epic discoveries, and the first of these milestones was the discovery of anæsthesia. It seems that America and England shared the early steps in anæsthesia, America with ether and Britain with gas and chloroform. The possibility of rendering the patient unconscious and insensitive to the pain removed one of the great barriers to surgery, and more operations now became possible for painful and life-endangering conditions. Still, the death rate remained high because all wounds became infected, and recovery from the simplest operation was a horribly painful and speculative business.

The next milestone, a great and undisputed triumph for this country, was raised by Lord Lister when, seeing the importance of Pasteur's discoveries in relation to surgery, he prevented the infection of operation wounds by destroying and excluding bacteria. At one stroke hundreds of new and helpful operation procedures became possible and mankind the world over reaped immeasurable benefit from Lister's great work, although, it is true, with some little delay because of scepticism on the part of the profession.

The next discovery worthy of being described as a milestone is the discovery of transfusion of blood from the healthy to the desperately ill. This has brought many previously hopeless cases, especially in war days, within reach of surgery and is one of the greatest life-saving discoveries. It is interesting that no less a person than Sir Christopher Wren foresaw the feasibility of this procedure and described the hypodermic needle for its performance.

The last milestone, chemotherapy, is as important as any of the others and is recent. Domagk's discovery of the sulphonamides after a slow start gave a great impetus to the control of infections through the blood stream. Up to this time there had been antiseptics, but they had all been as deadly to human life and human tissues as they had been to the bacteria. With the sulphonamides, however,there arrived the great antiseptic which had been dreamt of for many years, one which would kill

germs but was harmless to life and tissue. Following fast upon this came the elaboration of penicillin by Fleming and Florey, honoured by this Society with the award of the much-esteemed Albert Medal. Now, there is the most recent arrival of the twin sister of penicillin, the drug streptomycin, which destroys the germs which resist penicillin, even the most stubborn of all, the germ of tuberculosis. Defeated by these wonderful agents,the dangers of infection have all but disappeared from surgery, and the scourge of child-bed fever has vanished.

Alongside all these advances in surgical handicraft there has marched a steady improvement in the methods of diagnosis. To operate with a certain and exact diagnosis is to eliminate 90 per cent of the danger. X-rays have played the greatest part, and these rays, discovered over 50 years ago, as a result of the mathematical calculations of Clerk Maxwell, have now penetrated most of the secrets of the body. At first, the bones and their abnormalities were all that could be studied, but now the hollow organs can be filled with a substance which either prevents or facilitates the passage of the rays and their silhouettes photographed and abnormalities accurately diagnosed. The cavities of the kidneys can be filled with one chemical containing iodine and the gall bladder with another, the blood vessels with thorium, and the cavities of the brain can be filled with air. The air tubes of the lungs and the cavity containing the spinal cord can be visualised with a non-irritating oil containing iodine and the diagnosis exactly made. Before these methods were elaborated many an operation went wrong; because of the imperfection of diagnosis the surgeon would be embarrassed by an incision in the wrong place or he would be confronted with a condition for which he was unprepared or even the wrong kidney would occasionally be selected for operation.

Although X-rays have played the major part in improving diagnostic accuracy, great help has also been obtained from the biochemist in analyses of blood and other body fluids, and also the new science of electronics has given some assistance as will be shown in the subsequent lecture.

The present state of surgery is eminently satisfactory, and, at times, one feels tempted to say that now it has surely reached its zenith but for the recollections that surgeons have said this regularly every ten years since 1830. Surgery has reached out into every nook and corner of the human body, and every part of the human frame but the soul (and this seems even possible) has a chapter in the book of surgery. To prevent omission it will probably be best to consider the various parts of the body *seriatim.*

Abdominal surgery saw its greatest period in the 20 years from 1914 onwards, and, at present, it holds pride of place for surgical opportunities, for probably about three-quarters of all surgery takes place in the abdomen. Appendicitis takes first place, and although the operation seems prosaic now, nevertheless it saves a great number of lives each year for a death rate of less than one per cent. Gall bladder disease is now treated by radical removal of the organ with its contained stones, with a similar death rate. Ulceration of the stomach and duodenum, one of the curses of the hectic hurry and worry of these days, provides a large field for surgery, and the operations, although forced to become more and more radical, bring relief and happiness to those who for years have known no peace from pain. Cancer is rampant in the abdominal cavity, and takes a tremendous toll in the stomach, almost the worst

of all sites, but in the bowels there is a different story to tell, and surgery holds out brilliant results for those patients who hear Nature's warnings in time. Wonderful assistance is given to the surgeon by new developments of the sulpha drugs which, instead of being absorbed, remain in the gut, destroying all germs and rendering the contents odourless and clean during the period of operation and recovery. The use of these drugs has reduced the number of cases in which the bowel has to be brought to the surface temporarily or permanently, and this is no small boon to mankind.

The pancreas has provided a new field for surgery, and growths of this organ, previously always fatal, have been successfully removed. The patients with disease of this organ are usually deeply jaundiced and could not be operated upon because of the unstoppable bleeding produced by jaundice. This bleeding has been found to be due to the lack of absorption of a vitamine (K) when bile is absent in the alimentary tract. This deficiency is easily repaired, and jaundiced patients are now operated upon with no greater risks than others.

During the war some remarkable operations were done for injured blood vessels, and gaps in injured arteries were filled by means of tubes of rustless metals so as to maintain the flow of blood. This method has now been applied to certain situations in the body where a modification of Nature's plumbing seems to be required. In the veins substantial progress has been made and ulcers due to varicose veins can be healed with certainty. In the field of phlebitis and thrombosis great steps are reported. Drugs are available to control the clotting of the blood, and methods of preventing the separation of clots have been brought forward, and the terrible tragedy of the wandering and lethal clot has been 95 per cent. eliminated.

In gangrene of the extremities great help is given by dividing the nerves which control the blood vessels in properly selected cases. Ingenious electrical devices are also available to maintain an artificial circulation in the limbs so as to avoid amputation. With all these helps many limbs are saved nowadays which in recent years were unceremoniously lopped off. High blood pressure has come within the ambit of surgery in the last decade. It is a help in cases that are not too old or gone too far, and is particularly useful for women, especially those whose high blood pressure is due to child-bearing. The operation is directed towards the nerves which control the calibre of the blood vessels. After the operation, the vessels remain more widely open and do not provide the same resistance to the heart's pulsation, and, therefore, the blood pressure falls, and the vicious circle of this disease is broken. As this disease kills more than cancer, any advance brings hope to a large section of the human race.

In war wounds the nerves were often severed and the technique of sewing the ends of the nerves together achieved great delicacy. A new metal wire, flexible and non-corrosive, was manufactured from the rare metal tantalum, and, gossamer fine as the filament of an electric bulb, it made the suture of nerves a very neat job. Furthermore, delicate tubes of the same metal are slipped over the nerve junction to protect it from intrusions and damage while healing takes place. Nerve grafts to cover large gaps have not been of much value except in certain situations, the most important of which is the facial nerve, damage to which in ear disease produces a grotesque facial deformity. The remedy of this is a surgical triumph of the highest order. The graft used is derived from the patient himself. Fresh grafts from other

individuals, human or animal, always fail, and, needless to say, grafts taken from corpse and kept in the ice chest would be better left there than inserted into the patient.

Great progress in relief of pain and paralysis has come from the realisation that neuritis is a very rare disease and that, when pain comes persistently from one nerve, that nerve is being pinched or chafed somewhere and surgery can give relief. The two well known conditions of brachial neuritis and sciatica are fast becoming surgical complaints with imposing lists of cures mounting up.

The lungs have provided a recent and ever-increasing surgical field, progress in this branch of surgery being rapid and impressive. In consumption hope lies for an ever-increasing number of patients in surgery which is generally employed to remove the ribs and collapse the affected lung. American surgeons have recently dared to remove the tuberculous portions of the lung with success.

In chronic suppurations of the lungs large portions of the lungs are cleanly removed, and the life of the patient so afflicted is transformed from that of a malodorous social outcast to that of an acceptable member of the community with death removed to a respectable distance.

Cancer of the lungs is a formidable disease exacting a ghastly toll which is ever increasing and represents one of the protests lodged by our lungs against the tobacco and motor fumes which pollute our modern air. Surgery has come to the rescue in this dire disease, but only in a small way, which may improve as do all surgical results with early and more accurate diagnosis. It is a remarkable surgical achievement to remove a whole lung successfully for this disease, but this is now an everyday accomplishment with the patient managing more or less successfully on one lung and the space where the other one used to be.

Surgery of the brain is possibly the oldest surgery of all. The lunatic beating his head gave primeval man the idea of making a hole in the sufferer's skull, and judging from some of the skulls examined it seems to have done good because the patient had lived for some time after the operation. It is curious that there has been a return to this treatment in recent years in the operation known as leucotomy. This operation is reserved mainly for the sufferer from irrational restless misery, for the man who never ceases to accuse himself of some unmentionable sin or who, without cause, considers himself inflicted by some malignant or loathsome disease. It is felt in these cases that the patient has more brain than he can utilise successfully, and if the amount is reduced, stability and contentment will come when he is put on a slightly lower plane with four-fifths of the brain with which God over-endowed him. The extra fifth is not actually removed, but all its connections with the rest of the brain are severed so that it no longer shares in brain activities. It is interesting that the portion taken out of action is that portion most recently developed in the process of evolution, namely, the frontal lobes which fill the forehead. It must not be thought that the patient sinks to animal level, I know of one such patient able to shorthand and type in three languages, and another working as a newspaper reporter, and still another as a Professor of History! This operation may be further elaborated and certain specific portions of the brain removed for certain definite mental abnormalities. Surgery certainly has achieved something here to reduce the burden of mental disease on the nation. There are many of these cases also who are not bad enough to require

admission to a mental home but remain in their homes making all around them unhappy. As a result of operations on the insane quite a fair-sized contingent of lunatics have been discharged to their homes as useful citizens and others have been rendered much more amenable and, therefore, cheaper and easier to look after.

In other directions brain surgery has progressed; tumours are removed with low mortality, and in course of doing so quite large amounts of brain are removed. It is surprising how well one can live with so much removed. It seems that all the memories of education are carried in limited portions of the brain, and vast areas seem to have no function at all. If the whole brain were usefully employed what geniuses would abound! Macaulays and Miltons would be commonplace!

Abscesses in the brain carrying previously a 40 per cent. mortality have had this cut to 5 per cent., through one new discovery: that of penicillin. Ingenious operations have been devised to control constant and irremediable pain, and it is possible to dispossess certain areas of all disagreeable sensations of pain and temperature and yet retain sensations of touch, position and so on, and release the patient from the dreary tedium of drugs.

As a result of war wounds large areas of skull have been lost, and here dental technique has come to the aid of the surgeon. An accurate mould of the missing area is taken, and a plastic facsimile of the missing portion of the skull is made and fitted into the defect with a complete restoration of the contours, not a small matter when the forehead, eyebrows and root of the nose have been shot away.

The heart was one of the last organs to receive surgical attention, and here miracles of surgery have been achieved. During the recent war one American surgeon removed bullets or shell fragments from the hearts of 114 soldiers without a single death. Stab wounds of the heart are successfully sutured, especially for the romantic and quarrelsome negroes of the southern states of the U.S.A. The heart sometimes becomes encased in a kind of concrete chalk through tuberculosis. It can be shelled out of its carapace and set free to work efficiently again. Efforts have been made, not unsuccessfully, to control the pain of angina and reduce the death rate from this disease. There are some unfortunate children born with abnormalities of the heart and its great vessels and these poor patients eke out a miserable blue breathless existence till death releases them at an early age. For these there is surgical hope, and bold ingenious operations have returned the flow of blood to its normal channels and the child to a normal life.

In plastic surgery much effort and ingenuity is always to be seen, and one problem after another has been solved. Skin grafts are now cut with a planing machine to the exact shape and thickness required. The graft is then glued on to the area to be covered, with a glue manufactured from the patient's own blood. One constituent of the glue is painted on the underside of the graft and the other on the wound. As soon as the two are in contact a tenacious human glue is formed and the graft held securely in place. Human cement is also made by mixing this glue with bone dust made by grinding up a piece of bone obtained from the patient's side, and this material moulded in where it is required to fill an ugly hollow in the forehead or the bridge of the nose. The effort of plastic surgeons to help those mutilated in war is excellent and worthy work, but their efforts on behalf of the ageing female sex, are more debatable although it cannot be denied that these patients are grateful

for the staying of the remorseless hand of time. Large birthmarks, harelips, cleft palates, misshapen noses, elephantine ears and exaggerated prominences provide a worthy field of endeavour. Similar work to that done for the war-disfigured will present itself when petrol rationing is discontinued.

Eye surgery has not stood still. In recent years the grafting of the cornea of a clear eye to another with a film over the pupil has been carried out successfully, a most ingenious and delicate business. The operative treatment of squint has reached a high degree of perfection and no one need suffer from this humiliating complaint. In cases where the retina becomes detached from the back of the eye there is now a method of securing its replacement in its bed in more than half the cases. A few years ago loss of sight was inevitable in these cases.

Ear surgery has at last triumphed over the curse of deafness in a large contingent of the deaf, those who suffer from otosclerosis, a disease that is often familial. The operation is performed on the minute parts of the inner ear, and the work is so fine that the operation has to be performed under a special microscope. With this operation on the one hand and the better management of running ears with penicillin on the other, there is great hope of a substantial reduction in the deaf population of this country.

Although surgery seems to have gone from triumph to triumph it now seems that the field of surgery will ever diminish. The operative treatments of many diseases at present are makeshifts while we await elucidation of the causes and the medical treatment that will result from their discovery. Penicillin and streptomycin have eliminated some surgery already. Chemotherapy for tuberculosis will follow fairly soon, and so another field of surgical effort will disappear. Ulceration of the stomach and duodenum, diseases of the thyroid gland, high blood pressure and cancer are surely to become medical in their treatment, and the surgeon may be left to live on accidents and congenital deformities and, of course, the appendix which will never cease from troubling.

LECTURE II.—*Delivered 3rd February*, 1947.

APPLICATIONS OF RECENT PHYSICAL DISCOVERIES TO MEDICAL DIAGNOSIS AND TREATMENT

The contributions of chemistry to medicine are more obvious than those of physics. The amazing synthesis of drugs such as salvarsan and purification processes for penicillin and streptomycin have made a great impression, and the profession still looks to chemistry for much further help in the mitigation of suffering and the prolongation of life. Even the poison gases evolved in the last war have been found to have curative value, one for eye diseases and intestinal paralysis, and another for cancer. The anti-gas substance British anti-lewisite (B.A.L.) is a proved antidote to mercury, arsenic and antimony poisoning. The assistance of physics to medicine, though not so apparent, is very considerable, and every advance in the realm of physics is keenly studied by the medical profession for its possible application to treatment, diagnosis or research. It is the custom for every student of medicine to study physics during the first year of his apprenticeship; in the effort to reduce

the amount of study required for medicine it was at one time suggested that this subject should be dropped from the curriculum. I do not think that this will be mooted again for a long time, because physics now seems fated to play an ever-increasing part in the practice of medicine. The momentous advances in nuclear, physics which were occurring just before the war and were intensified during the war have opened new vistas for the doctor.

In America a committee has been formed under the sponsorship of the leading elder statesman and humanitarian, Mr. Bernard Baruch, to investigate all the facets of physical medicine. After its first report Mr. Baruch provided $1,100.00 to commence the work with a central office, administrative board and scientific committee. This gift has been trebled by educational establishments throughout the States. So biophysics is well launched on the other side of the Atlantic, and we will have to exert ourselves if we wish to keep our place in this important branch of medicine.

In the past, the greatest gift of physics to medicine was made by Roentgen when, following up the mathematical calculations of Clerk Maxwell, he gave us X-rays 50 years ago. There are many alive to-day who remember the great interest produced by that first ghost-like photograph showing the bones of the hand, and some can even remember the draper in Oxford Street who advertised ladies' underwear impervious to the X-rays. From that first discovery two medical specialities have been built up, one for X-ray diagnosis and the other for the treatment of disease by X-rays. Diagnosis by this means has reached amazing degrees of accuracy, and not only the bones can be studied, but every hollow space, tube or blood vessel in the body can be filled with either air or radio-opaque substances, and so photographed by the rays. Better and clearer pictures have been obtained by means common to other methods of photography; quicker films and intensifying screens to increase the illumination reaching the films have reduced the exposure time, and, therefore, the breath-holding on the part of the patient. The clarity of the pictures has been greatly increased by a simple device: a grid of metal slats close to the film which only permits rays at right angles to the film to pass. Thus the scattering of rays is prevented and an unblurred picture is obtained.

If the X-rays fall on a bright fluorescent screen the X-rays are turned into light rays and the picture produced can be photographed with a small camera and so miniature pictures of the chest can be taken. Large numbers of patients can be examined at small expense, and X-ray surveys of the chest can be made of the workers in mines and factories to detect early stages of lung disease, especially tuberculosis (mass radiography).

The electron beam may soon be used for intensifying the image on the X-ray screen and then television technique will play an important part as an adjuvant to the X-ray tube. This will prove to be a wonderful jugglery in rays. Cathode rays in the X-ray tube first produce X-rays which then pass through the patient and are in turn transformed into light rays by the fluorescent screen, then back to the cathode ray again to amplify the image and on another screen light rays produce the final image.

In the treatment of malignant disease progress has been obtained by more accurate measure of the dosage, more accurate direction of the rays to the disease target and

by raising the penetration of the rays by increasing their hardness. These hard rays are of shorter wave lengths and obtained by improving the X-ray tubes and increasing the voltage of the current used. The maximum attained to date is 1,000,000 volts, and this was done with difficulty and great expense and fell far short of the 2,000,000 volts which would be required to produce X-rays as hard as the gamma rays given off by radium. At the present time 200,000 volts is used as a rule in X-ray treatment.

The discovery of radio-activity by Becquerel in 1896 and radium by the Curies opened up a whole new field of possibilities. Atoms of helium (alpha rays) and electrons (beta rays) and electro-magnetic waves (gamma rays) were yielded by radium. The first, which are corpuscular waves, were used by Rutherford to smash the

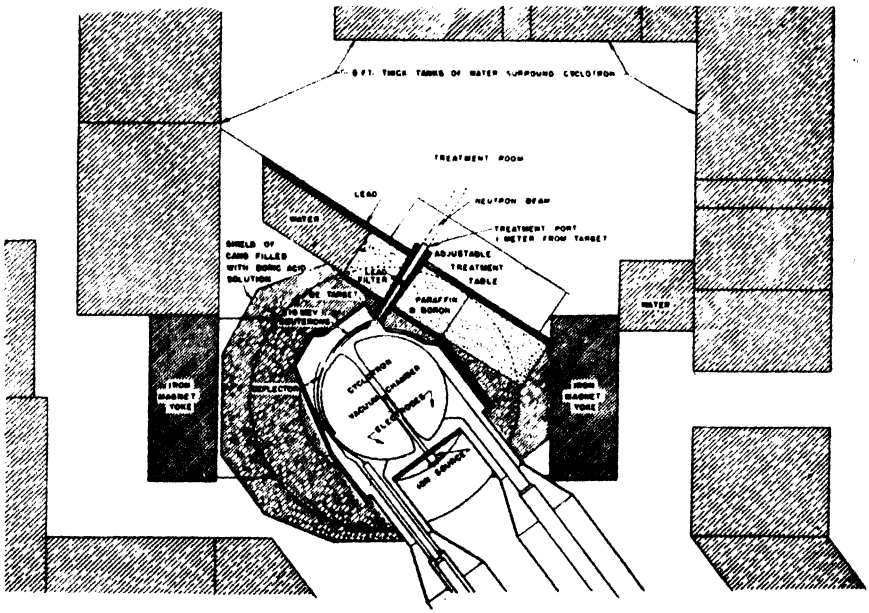


FIG. 1.—*Cyclotron arranged for the treatment by the neutron beam of a patient suffering from a malignant disease. Neutrons having no electrical charge are not stopped by lead screens, so the apparatus is surrounded by tanks of water.*

atom for the first time. The second, also corpuscular, were used by J. J. Thomson to create the electronic beam or cathode ray which has become the foundation stone in the vast new science of electronics. The last after being identified with X-rays, have become the essential factor in all treatment of malignant disease by waves which will penetrate deeply into the body to destroy malignant growths. As research was persisted in, the whole subject of nuclear physics opened up, revealing tremendous possibilities. It was realised that X-rays, in their effect on the tissues in general and malignant growths in particular, worked by virtue of ionising the constituents of the living cells, thus leading to their disorganisation and destruction. If this is the case, why not use some of the other rays which have been produced for the breaking up of the atom, which also produce ionisation in the living cells? Various atomic particles

are now known in addition to the electrons of beta rays, such as protons, deuterons, positrons and mesotrons (with electrical charges) and the neutrons (without any electrical charge). By various electric and magnetic devices these particles can be made to travel at prodigious speeds up to 40,000,000 miles an hour, and with this great speed they have great penetrative power and can reach deeply into human tissues and destroy growths lying well inside the body. The particles used so far are the electron and the neutron. The first, fast-moving penetrating beams, are provided by machines called the betatron and synchrotron. It is now possible to impart speeds to the electron corresponding to 100,000,000 volts as compared with the 1,000,000 volts of the strongest X-rays in existence and the 2,000,000 volts of the penetrating gamma rays of radium. Pencils of these fast moving electron streams can be directed to any part of the body, and it is to be expected that a far greater accuracy will be obtained than with any form of X-ray or radium rays. The high velocity neutron is obtained from a different machine known as the cyclotron. The neutron has no electrical charge and unlike the electron and the deuteron cannot be accelerated by electric and magnetic fields, so the particle used in the machine has to be the positively charged deuteron obtained from heavy water. The beam of deuterons now strikes a target made of the hard metal beryllum. Neutrons are then emitted, and these have now to be converted into a beam which can be focussed on to any part of the body. This beam produces 100 times as much effect as X-rays and promises to be of great value in the treatment of malignant disease. A peculiar feature of the neutron beam is that it passes through lead screens with the greatest ease, and to screen it off from nurses and assistants large three feet barriers of water, preferably containing boracic acid, have to be provided, instead of the lead screens used in X-rays.

These machines, betatron, cyclotron and synchrotron, were not devised for treating the sick, but for experiments in splitting the atom by bombarding the different elements with the fast-moving particles. It was found that of the 92 elements in existence 87 could be made radio-active and would give off similar rays to radium in the process of changing into other elements. Now these radio-active elements did not remain radio-active for long, some only for a second, others for a month; they were, therefore, unlike radium which takes 1,690 years to lose half its strength. Radium if taken into the body by swallowing or injection is not excreted and will produce fatal results eventually, as in the tragic case of the American girls who painted luminous dials of watches with a radium compound, licking their brushes in the process, and gradually absorbing enough radium to cause a slow death from radium damage to their tissues. Their last days and the manner in which they spent their compensation make a macabre story. Could the new substances with shorter lives than radium be administered in the correct doses with safety was now the question, and this was found to be so. By a method to be described later it was found that certain elements went to certain parts of the body. Phosphorus with a half life of 14 days went to the bones and could be used in treating malignant disorders of the bone marrow in which red cells are produced in great numbers (polycythæmia), or leukæmia in which white blood cells are in excess. Radio-active iodine went like normal iodine to the thyroid gland and its radiation there could treat over-activity or malignant disease of that gland. The destinations of other elements and compounds have still to be worked out, and, in time, we may have an element or a

compound for every structure in the body. The destination is found in one of two ways; either by injecting into an animal the radio-active isotope and dissecting the tissues after death and estimating the radio-activity of its various parts, or by finding during life the whereabouts in the body of the radio-active substance by means of a detector, known as the Geiger-Muller counter, or sometimes as the clucking hen because of the noise it produces. This instrument gives out a loud cluck each time it is struck by a corpuscular or electro-magnetic wave, and the patient who has swallowed some radio-active iodine will produce no reaction when the counter is run over the body except when the thyroid gland in the neck is reached, when a veritable farmyard din breaks out. Of the greatest value of all will be research carried out by attaching radio-active tracers to substances taken by the patient or laboratory animal. Suppose a teaspoonful of salt is taken which contains one granule of radio-active salt. This radio-active proportion will behave chemically exactly like the plain salt, and the wanderings of the salt in the body can be traced with ease in many million times less concentration than was used in the older methods of chemical analysis. In time innumerable secrets of growth and physiology will be disclosed by this technique. Poisons will be followed in the body and their mode of action discovered.

The betatron and cyclotron were introduced to take the place of the electrostatic generators used for the highest voltage X-rays. These huge generators required an aircraft hangar to house them and cost large sums of money. The betatrons and cyclotrons worked from quite reasonable voltages (10,000 volts) and were much simpler and easily contained in a single room, but nevertheless were delicate complicated instruments requiring a great deal of supervision and experience in their handling and showing great liability to break down. It is possible that now they will be superseded by the latest product of nuclear research, the uranium pile. Otto Hahn in 1937 discovered the fact that the radio-activity of uranium was associated with the splitting of its nucleus in two parts (fission), and the free neutrons and electrons were produced with a greater release of atomic energy than was ever known before. Later research showed that it was an isotope of uranium which was split, uranium 235, and this substance was only one per cent. of natural uranium. There were two ways of utilising this vast source of atomic energy, one war-like by making atomic explosives and the other peaceful, creating heat for industry and radio-active isotopes for medicine. In explosives a large piece of the substance was used; for heat the uranium was sub-divided into cylinders which were imbedded in a large block of graphite encased in concrete. The radio-active processes were regulated by cadmium sleeves sliding over the uranium cylinders. In the interior of one of these radio-active piles there is intense radio-activity, and the yield of one pile of radio-active isotopes is 1,000 times greater than one cyclotron or betatron. It is considered that the pile now being built near Aylesbury will provide all the products needed for this country. To obtain radio-active substances for treatment or research it is only necessary to put the parent substance inside one of the uranium cylinders of the pile and slide it into the pile. The intense bombardment with neutrons quickly produces the requisite change, and the substance is ready for use. Four hundred and fifty radio-active substances have been prepared so far, and many others will follow with different uses. From the intense corpuscular bombardments inside the

pile beam therapy can be obtained with neutron beams from the fission products produced in the pile, or from cubes of uranium cobalt or tantalum which have been rendered radio-active in the pile.

The cathode ray is produced in a vacuum tube. It consists of a stream of electrons leaving the cathode (negative pole) at great speed at right angles to its surface. They carry positive electric charges and travel in one direction, unless deviated by electric and magnetic fields of very slight intensity. This delicate method of measurement enabled the small active currents of the body to be studied. The human body is full of electrical currents; every beat of the heart starts five electric currents, each nerve impulse and muscle contraction starts many more, and in the brain action currents are produced 14 times every second. These currents are always cause for wonder to me, hundreds of them every second in life, all vanishing at the moment of death. The measurement and tracing of these currents in health and disease is greatly

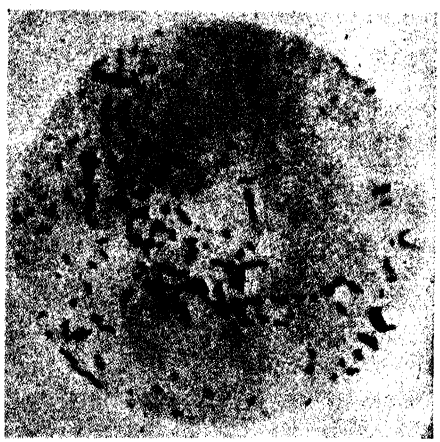


FIG. 2.—*Hundreds of typhoid organisms as seen by an ordinary microscope.*

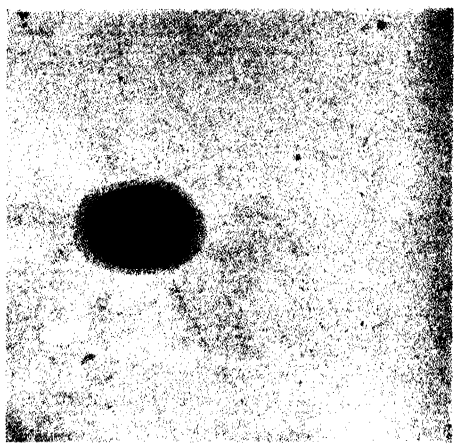


FIG. 3.—*A single organism as revealed by the electron microscope.*

simplified with the cathode ray for purposes of research. In diagnosis the method is of great value in the study of heart disease and in discovering the position of brain tumours and the origins of epilepsy. The possible use of the cathode ray in amplifying the strength of X-ray photographs has been alluded to previously.

One of the most amazing developments of the electronic beam is the electron microscope invented by Dr. Hillyer of Toronto. In this instrument the electron beam passes through "lenses" produced by electro static fields and produces an image which may be magnified as much as 100,000 times. Bacteria appear like large breakfast sausages and the viruses hitherto invisible are like chipolatas. The structures of the living cells and their nuclei can now be studied as never before and the position of the genes in the nucleus of sex cells discovered. These genes, whose presence had been already inferred mathematically, control the development of the future organism and are the basis of the subject of eugenics. A small pencil beam of electrons can be used in the electron microscope to probe still further into the structure of bacteria cells and viruses. So tiny is the beam that it would be possible with it to

write one's signature on the side of a bacterium. Not satisfied with this, progress is being made with the analysis of the molecule of protein by means of a combination of this electron probe, X-ray analysis and the centrifuge microscope.

The field of electro-magnetic waves varies from electric waves a million miles long, down to the cosmic rays, 300 billion of which are covered by one inch. The next waves below the electric waves are the radio waves, and the shorter forms of these have been used in medicine under the name of short-wave therapy. During the war, by means of a special valve, the magnetron, very short waves were produced by radio-engineers in this country, and the part these played in anti-submarine warfare is now well known. These short waves can now be focussed into narrow beams and

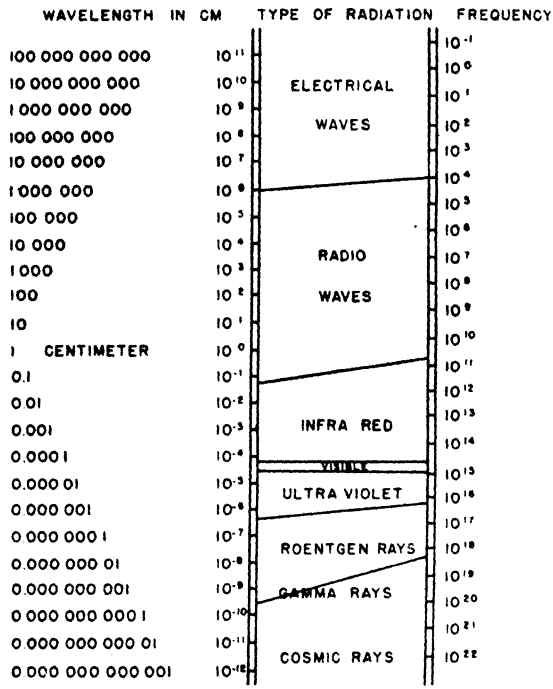


FIG. 4.—*The whole gamut of electro-magnetic wave radiations. Note that the visible rays are only one hundredth part of the whole spectrum*

directed towards a deep region in the body. Two beams can be made to intersect in an area two inches in diameter, electric energy being released there as heat, and so it will be possible to heat up a definite area deep in the body to any temperature. Next below the radio waves are the infra-red or heat waves, and these are used for treating the more superficial parts of the body. These rays can also be used for visualising photographically structures beneath the skin just as they were used in the war for photography through clouds.

The next rays are the light rays which, with sound waves, were our only avenues of knowledge a quarter of a century ago. Passing from the light waves we come to the ultra-violet waves which are used for treatment of skin conditions. A remarkably ingenious use has been made of these rays recently. They have a remarkable power

of producing fluorescence in certain substances. If the blood stream of a patient is injected with fluorescein, then the tissues illuminated with ultra-violet light will glow when the substance reaches them. So one can tell if fingers and toes receive enough blood supply, or if a skin graft is going to live, and so on. Ringworm of the hair of the head and fur of domestic animals is also revealed by ultra-violet rays, which are in daily use for the simple diagnosis of these diseases. Living teeth show a heliotrope glow in these rays whereas dead teeth do not light up, and with these rays the vitality of the teeth can be demonstrated.

Beyond the ultra-violet light come the grenz rays, the roentgen rays and the gamma rays, all of which have been considered previously. These are the most valuable of all rays to the science of medicine in diagnosis and treatment of disease.

Last of all come the mysterious cosmic rays which keep winging to the earth at a speed of 175,000 miles a second. They penetrate everything, and everybody in this audience has two of these rays penetrating him at any moment and plunging down through the foundations of this building and reaching a mile or more into the earth's crust. If these rays were more numerous we would die of their effect because they are very lethal, but fortunately the earth's atmosphere cuts off large numbers of them—high up in the stratosphere they occur in numbers which would be dangerous to life.

Sound waves have been amplified to help the deaf, and hearing aids will benefit by war-time research. Hearing aids used from the electric mains will soon be available, and a new aid is promised whereby the user will know from which direction a sound is coming and reverberation will be eliminated. During the war the supersonic waves were used in the Asdic apparatus for locating submarines. These waves were known to be used by bats who avoid objects in the dark by receiving the echo of the supersonic waves which they emit, and experiments are now in progress to try and develop in the blind the same senses that guide the bat. A French scientist has also designed an instrument for directing hypersonic waves into the body where they are turned into heat with curative value. These waves are lethal to the virus of mosaic disease of tobacco leaf and, therefore, may become of use in the treatment of human diseases.

The advances in physics of recent years are incredible. It seems that we have almost acquired new senses in addition to vast powers. Mankind ultimately may make bad uses of these new powers, but medicine will make good use of them meantime, and maybe some day find a formula, not only for the diseases of the individual, but for the diseases of nations.

OBITUARY

SIR ALFRED PICKFORD.—We regret to announce the death on Tuesday, October 7th, of Sir Alfred Pickford, who had been a Life Fellow of the Society since 1937. He will be chiefly remembered for his work with the Boy Scouts, especially with the Indian movement.

He was born in 1872 and after being educated in Scotland, he went out to Calcutta where he ultimately became head of the firm of Begg, Sutherland & Co., also filling many public appointments. In 1921 he was knighted and awarded the Kaisar-i-Hind Gold Medal for social service, and in 1946 he was awarded the O.B.E.

SIR ROBERT GRAHAM.—We regret to announce the death, on Thursday, October 16th,

of Sir Robert Graham, at the age of 71. He had been a Fellow of the Society since 1939 and had held the office of Chairman of the International Tea Committee since it was constituted in 1933. During his life he had held many key positions in the Indian Tea Industry and he was knighted in 1935.

NOTES ON BOOKS

THE BATTLE OF THE BOOKS. Edited by Gerard Hopkins. Allan Wingate. 1947. 2*s.* 6*d.*

This is a most important and timely brochure, the proceeds of which will benefit the benevolent fund of the booksellers' organisation. Edited by a distinguished publisher, Mr. Gerard Hopkins, and issued by Mr. André Deutsch, the enterprising director of one of the younger publishing houses, the book aims to present the manifold problems confronting the book trade "approached from different and well-informed viewpoints".

Close on twenty papers, written with admirable clarity and forbearance, and contributed by a company of experts, state the cases of the author, publisher, educationist, journalist, printer, paper-maker, binder, literary agent, bookseller and librarian in the present grave crisis in the trade.

The problem is not merely one of paper. As Mr. Leonard Brooks points out, in his article calling attention to the serious position created by the shortage of books in educational institutions, all the processes of book production are affected—printing, stitching, binding and cloth for binding, as well as the supply of new machines.

With so many just claims, it is difficult to establish a proper order of "priorities", as Mr. Hopkins remarks; but it is necessary to stress the grievance of the younger publishers whose paper ration is totally inadequate to their needs.

N. A. D. WALLIS.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

MONDAY, OCTOBER 27..Electrical Engineers, Institution of, W.C.2. 5.30 p.m. P. Good, "**Standardization in the Electrical Industry**"
At the Neville Hall, **Newcastle-on-Tyne.** 6.15 p.m. D. E. Lambert and J. Christie, "**Standardization of Switchgear.**"
Farmers' Club, at the Royal Empire Society, W.C.2. 2.30 p.m. Mr. Clyde Higgs, "**Dairy Farming—Changes Ahead.**"

TUESDAY, OCTOBER 28..Electrical Engineers Institution of, at the Electricity Department Showrooms, **Leeds.** 6.30 p.m. F. Widnall and R. Newbound, "**Protective Finishing of Electrical Equipment.**"
At the Engineers' Club, **Manchester.** 6 p.m. W. H. L. Lythgoe, "**Standardization of Power Cables.**"

WEDNESDAY, OCTOBER 29..Electrical Engineers, Institution of, at the Harris Institute, **Preston.** 6.45 p.m. A. Burke, R. C. Cuffe and W. O'Neill, "**Record of Experience on the Irish Electricity Supply System.**"
Foundrymen, Institute of British, at the Waldorf Hotel, W. 7.30 p.m. R. B. Templeton, "**The Production of Cast Crankshafts.**"

FRIDAY OCTOBER 31..Chemical Society, at The University, **Glasgow.** 3.45 p.m. Professor H. Nicol, "**From the Highest to the Lowest.**"
Engineers and Shipbuilders, North East Coast Institution of, at the Literary and Philosophical Society, **Newcastle-on-Tyne.** 6.15 p.m. T. W. F. Brown, "**A Marine Turbine, Research and Testing Station.**"
Mechanical Engineers' Institution of, Storey's Gate, S.W.1. 5.30 p.m. T. A. Kestell, "**Turbine Blades for the Whittle Engine.**"
Royal Institution, W.1. 9 p.m. Earl de la Warr, "**Problems facing British Agriculture.**"

MONDAY, NOVEMBER 3..Electrical Engineers, Instituton of, at Kings College, **Newcastle-on-Tyne.** 6.15 p.m. H. Cobden Turner and G. M. Tomlin, "**The Application of Electrical Technique to the Service of some other Industries.**"
Engineers, Society of, at the Geological Society, W.1. 5.30 p.m. R. C. Smart, "**Industrial Organisation, as a Factor in Production Efficiency.**"
Geographical Society, Royal, S.W.7. 5.30 p.m. A. Champion— "**East African Rites and Customs.**"

TUESDAY, NOVEMBER 4..Chadwick Trust, at The Livingstone Hall, 42 Broadway, S.W.1. 2.30 p.m. Dr. C. T. Maitland, "**Hospitals and Health Services**"
Chemical Engineering Group at the Geological Society, W.1. 5.30 p.m. L. Rotherham, "**The Selection of Stainless Steels for the Chemical Engineering Industries.**"
Electrical Engineers, Institution of, at the Engineers' Club, **Manchester.** 6 p.m. J. R. Mortlock and C. M. Dobson, "**Neutral Earthing of Three-Phase Systems, with particular reference to Large Power Stations.**"
Kinematograph Society, British, at 16 St. Mary's Parsonage, **Manchester.** 10.30 a.m. J. C. Milne, "**Arc Lamp Conversion Equipment.**"
At Neville Hall, Neville Street, **Newcastle-on-Tyne, 1.** 10.30 a.m A. Brown, "**A Treatise on Kinema Arc Lamp Reflectors.**"
Mechanical Engineers, Institution of, S.W.1. 6 p.m. M. A. Jullien, "**Independent Suspensions Systems.**"
East India Association, at the Royal Society, W.1. 2.30 p.m. Habib Ibrahim Rahimtoola, "**The Ideals and Prospects of Pakistan.**"

WEDNESDAY, NOVEMBER 5..Electrical Engineers, Institution of, W.C.2. 5.30 p.m. G. D. Reynolds, "**Tests for the Selection of Components for Broadcast Receivers.**"
At the University College, **Southampton.** 6.30 p.m. V. J. Francis and W. R. Stevens, "**The High-Pressure Mercury-Vapour Discharge and its Applications.**"

THURSDAY, NOVEMBER 6.Electrical Engineers, Institution of, W.C.2. 5.30 p.m. C. M. Cock, "**Electric Traction on the Southern Railway.**"
Royal Society, W.1. 4.30 p.m. H. R. Ricardo, "**Some Problems in Connexion with the development of a high-speed Diesel Engine**"
Town and Country Planning Association, 28 King Street, W.C.2. 1.15 p.m. Leslie Hardern, "**Town Planning and Fuel Planning.**"

FRIDAY, NOVEMBER 7.Electrical Engineers, Institution of, W.C.2. 5.30 p.m. S. Hanford, "**Telephone Cable Measurements.**"
Mechanical Engineers, Institution of, S.W.1. 5.30 p.m. R. C Farker and P. R. Marshall, "**Sliding Surfaces. with special reference to Railway Brake Blocks.**"
Royal Institution, W.1. 9 p.m. Professor E. K. Rideal, "**Foam.**"



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JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4755 *FRIDAY, NOVEMBER 7th,* 1947 Vol. xcv

MEETINGS OF THE SOCIETY

The following meetings of the Society are to take place within the next fortnight:—

Ordinary Meetings

Wednesday, November 12th, at 2.30 p.m.—Craftsmanship—(i) "The Crafts—Their Past, Present and Future". By John Farleigh, A.R.E. A. E. Richardson, R.A., F.R.I.B.A., Professor of Architecture, Royal Academy Schools, in the Chair.

Wednesday, November 19th, at 2.30 p.m.—"The Development of Sound Recording and Reproduction". By Sir Ernest T. Fisk, Managing Director, Electric and Musical Industries, Ltd. Sir Noel Ashbridge, B.Sc., M.I.E.E., Deputy Director-General, British Broadcasting Corporation, will preside. (Illustrated by lantern slides and demonstrations.)

Dominions and Colonies Section

Tuesday, November 18th, at 2.30 p.m.—(*Neil Matheson McWharrie Lecture*) "Scientific Research in Canada and its Links with Science in the United Kingdom". By Dr. J. G. Malloch, M.B.E., Chief Scientific Liaison Officer, National Research Council of Canada. Sir Edward V. Appleton, G.B.E., K.C.B., F.R.S., Secretary, Department of Scientific and Industrial Research, will preside.

Cantor Lectures

Monday, November 10th, at 4.30 p.m.—"Modern Danish Design". By Steen Ejler Rasmussen, Hon.R.D.I.

Monday, November 17th, at 4.30 p.m.—"The Effect of Advertising on Commercial Design". By Ashley Havinden, R.D.I.

REPORT ON THE SOCIETY'S EXAMINATIONS, FOR THE SESSION 1946-1947

INTRODUCTION

It is possible to deduce from the statistical tables at the end of this report something of the nature of the basic time-table of those normal institutions for further education that close the work of the session with the holding of the Royal Society of Arts' Examinations. The 81,723 papers worked represent a 10 per cent. increase on the 1946 total and the total is made up, as to over 75 per cent. of the entries, of five subjects, in order of bulk—Typewriting, Shorthand, Book-keeping, English and Arithmetic. Typewriting papers form just over 25 per cent. of the whole, with Shorthand close behind at 25 per cent. almost exactly, the other three subjects representing 12½, 7½ and 6 per cent. respectively. Of the remaining subjects French, at just under 3 per cent., is well ahead of all the other 27 subjects which account for the remaining 20 per cent. The reader is left to draw his own conclusions.

The gradual expansion of the examination work of the Society to the pre-war level is a measure of the increase in further education of that type covered by the examinations syllabuses, and one phase of the Society's work is seen in the growing recognition that the single subject should not be regarded as the limit of examination activity. The entries in the Transport Examinations have passed the 1,000 mark and there is an increase of nearly 1,000 entries in the Grouped Course Examinations The new Junior Shorthand-Typist's Certificate and the remodelling of the senior grade syllabus are signs of the times and teachers are recommended to give these composite examinations their careful consideration.

During the session under review an adventure into the field of overseas examinations has been made. The examiner's report on "English for Dutch students" shows an enthusiasm which is, indeed, heartening, and directs the attention of the Society to a work which may well be the means of strengthening the bond of friendship with Holland and with any other country to which this form of examination may be extended. The examiner says "there is here a wide and fertile field to cultivate", and, again, "the success of this new venture appears to be certain". Indeed, very early in the formulation of the scheme it was surmised that the year's syllabus only touched the fringe of the subject, and the Society proposes to extend its activities to meet what has hitherto been but an inarticulate demand.

The reports* in general direct the attention of students and teachers to the virtues, as well as the shortcomings, of the examination scripts and, in particular, excellent advice is given by the examiners in Shorthand, Typewriting and Book-keeping. Action on these very detailed criticisms of the work of candidates cannot fail to produce better-equipped examinees in future examinations, and also—what is perhaps more important—more satisfactory employees in the world of Commerce.

R. W. H.

[*N.B.—The Examiners' Reports have, on account of the present paper restrictions, been omitted from the following pages. The complete report will be published in a separate pamphlet by the Examinations Department, and a copy will be sent to any Fellow who applies to the secretary.]

List of Entries, 1946–1947

The total number of single-subject entries for the various examinations, conducted by the Society between November, 1946 and July, 1947, was 87,992, as compared with 80,345 for the corresponding series in the period from November, 1945 to July, 1946.

The following table gives a detailed comparison:

	1946–1947	1945–1946
(*a*) Ordinary (Single Subject) Examinations	73,400	67,020
(*b*) Senior School and School Commercial Certificate	6,902	7,176
(*c*) L.C.C. and Home Counties Grouped Course	5,756	4,921
(*d*) Oral examinations	453	486
(*e*) Transport examinations	1,364	742
(*f*) English for Dutch Students in Holland	117	—
	87,992	80,345

The increase of 7,647 in the entries for the current session, shown by the above figures, was contributed to, as will be noted, by all the series except the School Commercial Certificate and the Oral examinations. The causes of the small falling-off in these two cases are almost certainly non-recurrent and the entries should, in the near future, recover the lost ground. The total entries of the Ordinary (Single Subject) Examinations show for the whole session a satisfactory increase of over 6,000, despite the small increase in the entrance fees for 1947. There was a smaller entry for the Easter Ordinary Series in 1947 than in Easter, 1946. This was, no doubt, due to the bitter wintry weather and the subsequent floods which prevailed from the time of entry up to and including the actual period of examination. This small decline was, however, turned into the substantial increase shown by the entries at the Whitsun and Summer Series.

In the two Transport Schemes, Scheme A still continues to attract candidates—there was an actual increase in the entries—while the entries for the comparatively new Scheme B more than doubled themselves with over 1,000 entries.

The decision to hold the Grouped Course examinations at both the Whitsun and Summer Series justified itself with a total entry of 5,756, an increase of 835 over last year.

The "Introduction" refers to the examinations in English for Dutch students and to the examiner's report on this, the first examination the Society has held abroad in a foreign country as distinct from those held for many years past in British Colonies and Dependencies. The next examination at the Hague will be held in November, 1947.

Papers Worked, 1946–1947

The number of papers worked, as distinct from entries, at the Society's examinations between November, 1946 and July, 1947 was 81,723.

The details for the various series are:

(*a*) Ordinary (Single Subject) Examinations	68,871
(*b*) Senior School and School Certificate	5,734
(*c*) L.C.C. and Home Counties Grouped Course	5,366
(*d*) Oral Examinations	398
(*e*) Transport Examinations	1,237
(*f*) English for Dutch Students in Holland	117
	81,723

The figures for *papers worked* shown above and throughout the report are only approximately correct. About 1,300 papers worked at overseas centres, the return of which has been delayed, will require to be added.

Notes on the various series of examinations follow.

Ordinary (Single Subject) Examinations

Examinations will be held in 1948 at Easter, at Whitsun, at the Summer Series in July, and in the Autumn. The period of the Summer Examinations has been extended by two days in view of the large number of subjects at that series, and this has necessitated a re-arrangement of the time-table.

Details of this year's results are shown in the Table on page 811.

Full details are given in the Programme for 1948, which may be obtained from the Examinations Officer, Royal Society of Arts Examinations Department, 28 Victoria Street, London, S.W.1.

Oral Examinations

This test is compulsory in the Advanced Stage of French, German, Italian, Russian and Spanish. The number of candidates presenting themselves for examination this year was 398, of whom 152 passed with distinction, 199 passed and 47 failed.

An important part of the Oral Test is the taking down of a passage dictated by the Examiner in the foreign language. It is found that many candidates who attend the Oral Tests have had the advantage of residence in the foreign country, and in consequence possess an extensive vocabulary and an excellent colloquial knowledge of the language; but in many instances they have not paid sufficient attention to the grammar, and on account of this weakness they frequently fail in the dictation because their verbs and terminations are faulty.

Special Examinations

Apart from the Ordinary (Single Subject) Examinations, the Society conducts a number of special examinations, particulars of which may be obtained from the Examinations Officer. Details of this year's results are shown in the tables on pages 808–811.

Senior School and School Commercial Certificate.—These examinations were instituted in 1927 and are held annually in March and July (the Senior School Examinations are held in July only). They are intended for pupils of day schools, and candidates are required to pass in four compulsory and at least three optional subjects.

Grouped Course Examinations.—A Grouped Course Examination, instituted in 1927 for students of the London County Council Junior Commercial and Junior Technical Institutes, is conducted by the Society each year; this series was later extended to similar Institutes in the Home Counties. Examinations will be held in 1948 at the Whitsun and Summer Series. Candidates under the London County Council must take one of the following groups: (*a*) Commercial Grouped Course—English and Arithmetic and *either* Book-keeping, Shorthand *or* French; (*b*) General Grouped Course—English and Arithmetic and *either* History *or* Economic Geography; (*c*) Technical Grouped Course—English, Mathematics and Technical Drawing *or* English, Mathematics and Science *or* English, Trade Calculations and Technical Drawing.

Examinations for the Staffs of Road Transport Undertakings

Scheme "A".—The Society was, in 1935, asked to hold examinations, and issue certificates to successful candidates, in a three-year course of study which was designed to enable transport employees to gain a knowledge of road transport, both in its immediate and wider aspects. All students completing the course successfully are awarded the "Diploma in Road Transport", which is considered a qualification in the road transport industry.

The first examination was held in May, 1936, and the examinations have been carried out in each succeeding year, with the exception of 1942, when they lapsed owing to the small number of candidates interested. They will be continued in 1948 at the Whitsun Series.

Scheme "B".—In 1945, the Road Transport Education Conference, representative of leading organisations in the road transport industry and in education, asked the Society

to set up another series of examinations in connection with the Conference's scheme of vocational instruction for employees in the industry. The examinations are of a practical character, designed for those who are not intending in the first instance to proceed to higher examinations.

The examinations were first held in May, 1946, and will be carried out in succeeding years at the Whitsun Series.

The managements of the three Transport periodicals, "Bus and Coach", "Transport World", and "The World's Carriers", in addition to continuing their offer of money prizes in Scheme "A", are, in 1948 and after, generously offering similar prizes to Scheme "B" candidates.

Group Certificates in Commercial Subjects

28 Group Certificates in the Advanced and Intermediate Stages have been applied for, as well as 24 in the Elementary Stage. The small number of applications in the latter stage is partly due to the fact that some centres which should have normally applied by now for Group Certificates have not yet done so.

Medals

At this Session's examinations 22 candidates qualified for the Silver Medal in the Advanced Stage and 53 for the Bronze Medal in the Intermediate Stage. They have been awarded the special medal certificate together with a money prize, to the value of £1 10*s.* in the case of the Silver Medal and of 15*s.* in the case of the Bronze Medal.

The Clothworkers' Company generously continued their gift towards the cost of the money prizes in 1947.

SPECIAL PRIZES

The Duke of Connaught Prize

This Prize consists of Life Fellowship of the Society, together with a gift of £5 in books to each successful competitor. Up to four Life Fellowships and gifts of books are offered annually. The conditions of the award are as follows:

(1) Candidates of any age may compete.

(2) Candidates must be of British nationality.

(3) The prizes are awarded to the candidates who obtain the highest total of marks at the Society's examinations in any one year in three of the following subjects in the Advanced Stage (Stage III)—Economic Geography, Economic and Social History, Economic Theory, English, History of the British Empire, History of the United States of America, a foreign language (only one foreign language may be offered).

[Candidates must obtain a First or Second-class pass in all three subjects.]

During 1946–47 no candidate achieved a sufficiently high standard to merit an award.

Prizes in History of the British Empire and History of the United States of America

The Society offers the following prizes to candidates annually, under the conditions detailed:

History of the British Empire—

Stage III (Advanced), 1st Prize £20, 2nd Prize £10; Stage II (Intermediate), 1st Prize £10, 2nd Prize £5; Stage I (Elementary), 1st Prize £6, 2nd Prize £4.

History of the United States of America—

Stage III (Advanced), Single Prize £15; Stage II (Intermediate), Single Prize £10; Stage I (Elementary), Single Prize £5.

The prizes are awarded for the best papers in each stage of the subject at (*a*) any of the series of the Society's Ordinary Examinations, or (*b*) the appropriate stage of School and Senior School Commercial Certificate Examinations in any one year, subject to the following conditions:

(i) Age Limits:
For Stage III—No age limit.
For Stage II and Senior School Commercial Certificate Examinations—No age limit.
For Stage I and School Commercial Certificate Examinations—Candidates must not have reached the age of 18 at the date of examination.

(ii) Students of British nationality only are eligible.

(iii) No prize is awarded to a candidate whose work in the opinion of the Society's examiners is not sufficiently meritorious.

(iv) No prize is awarded unless the Council of the Society considers the numbers of entries adequate.

(v) No prize is awarded to a teacher of History, or in Stages III and II to a candidate who, having reached the age of 18 at the date of examination, is following a full-time course of study in cognate subjects.

The following awards were made in 1947:

History of the British Empire (School Commercial Certificate Examination.)—
1st Prize of £6—Agnes Lee, Palatine Secondary School, Blackpool.
2nd Prize of £4—Hilda Taylor, Palatine Secondary School, Blackpool.
(No prizes were awarded in the Intermediate and Advanced Stages.)

History of the United States of America Stage II (Intermediate)—
Prize of £10—June Jagger Schofield, Grammar School, Fleetwood.

Stage I (Elementary)—
Prize of £5—Joyce May Wills, Public Secondary School, Plymouth—
(No prize was awarded in the Advanced Stage.)

TABLE OF RESULTS OF THE L.C.C. GROUPED COURSE EXAMINATIONS, 1947

	Papers Worked.	*Passed with Credit.*	*Passed.*	*Not Passed.*
TECHNICAL:				
English	687	42	495	150
Mathematics	323	181	86	56
Trade Calculations	376	121	126	129
Science	11	3	6	2
Technical Drawing	687	128	341	218
TOTALS	2,084	475	1,054	555
COMMERCIAL:				
English	227	8	151	68
Arithmetic	223	37	84	102
Book-keeping	121	7	42	72
Shorthand—60 w.p.m.	10	—	7	3
,, 50 w.p.m.	66	—	21	45
French	21	5	12	4
Economic Geography	22	5	5	12
History	6	—	—	6
TOTALS	696	62	322	312

TABLE OF RESULTS OF THE HOME COUNTIES GROUPED COURSE EXAMINATIONS, 1947.

	Papers Worked.	*Passed with Credit.*	*Passed.*	*Not Passed.*
TECHNICAL:				
English	608	31	467	110
Mathematics	533	338	131	64
Trade Calculations	136	55	60	21
Science	236	43	97	96
Technical Drawing	583	137	283	163
TOTALS	2,096	604	1,038	454
COMMERCIAL:				
English	143	11	106	26
Arithmetic	142	57	62	23
Book-keeping	109	10	52	47
Shorthand—60 w.p.m.	24	—	16	8
,, 50 w.p.m.	20	—	9	11
French	48	12	29	7
Economic Geography	3	2	—	1
History	1	—	—	1
TOTALS	490	92	274	124

TABLE OF RESULTS OF THE TRANSPORT EXAMINATIONS, 1947.

	Papers Worked.	*1st Class.*	*2nd Class.*	*Not Passed.*
Scheme "A."				
Group I.—Economic Geography	38	10	20	8
Commerce and Business Routine	36	3	25	8
Elements of Transport	46	10	20	16
Group II.—Principles of Accounts	17	1	9	7
Law relating to Road Transport	12	5	6	1
Economics applied to Road Transport	55	14	29	12
Group III.—Elementary Statistics	29	6	13	10
Law of Inland Carriage	29	10	16	3
Road Transport Operation	58	21	30	7
TOTALS	320	80	168	72
Scheme "B."				
1st Year.—Road Transport Operation (Passenger)	291	52	154	85
,, ,, ,, (Goods)	46	18	21	7
Elements of Road Transport Engineering	171	60	79	32
Road Transport Accounts and Statistics	241	17	137	87
2nd Year.—Road Transport Operation (Passenger)	41	5	18	18
,, ,, ,, (Goods)	25	8	16	1
Elements of Road Transport Engineering	41	14	24	3
Road Transport Accounts and Statistics	47	5	30	12
3rd Year.—Road Transport Operation (Passenger)	2	—	1	1
,, ,, ,, (Goods)	1	1	—	—
Elements of Road Transport Engineering	2	—	1	1
Economics applied to Road Transport	9	1	6	2
TOTALS	917	181	487	249

SENIOR SCHOOL AND SCHOOL COMMERCIAL CERTIFICATE EXAMINATIONS, 1947.

NUMBER OF FULL CERTIFICATES AWARDED.

SENIOR SCHOOL COMMERCIAL CERTIFICATE.

Candidates, 33; First-class certificates, nil; Second-class certificates, 7.

SCHOOL COMMERCIAL CERTIFICATE.

Candidates, 695; First-class certificates, 46; Second-class certificates, 345.

TABLE SHOWING THE NUMBER OF PAPERS WORKED IN THE SENIOR SCHOOL AND SCHOOL COMMERCIAL CERTIFICATE EXAMINATIONS IN MARCH AND JULY, 1947, TOGETHER WITH THE RESULTS.

SUBJECTS.	SENIOR SCHOOL CERTIFICATE EXAMINATION. JULY.				SCHOOL CERTIFICATE EXAMINATION. MARCH.				SCHOOL CERTIFICATE EXAMINATION. JULY.			
	Number of Papers worked.	Passed 1st Class.	Passed 2nd Class.	Failed.	Number of Papers worked.	Passed with Credit.	Passed.	Failed.	Number of Papers worked.	Passed with Credit.	Passed.	Failed.
Arithmetic ...	33	8	8	17	81	13	29	39	609	165	259	185
Book-keeping ...	33	5	15	13	81	14	33	34	610	197	199	214
Economic Geography	33	1	6	26	81	6	40	35	609	42	220	347
English	76	11	53	12	81	5	57	19	569	67	402	100
Commerce ...	31	4	19	8	64	2	46	16	420	30	278	112
French*	5	1	3	1	10	9	1	—	383	69	176	138
German	—	—	—	—	—	—	—	—	2	—	—	2
Spanish	—	—	—	—	—	—	—	—	20	—	6	14
History	2	—	2	—	4	—	4	—	355	38	125	192
History of the British Empire	—	—	—	—	—	—	—	—	57	6	23	28
History of the U.S.A.	—	—	—	—	5	—	5	—	14	3	7	4
Mathematics ...	4	1	2	1	—	—	—	—	233	60	109	64
Natural Science...	—	—	—	—	—	—	—	—	103	36	54	13
Shorthand† ...	32	3	6	23	81	19	36	26	494	125	109	260
Typewriting ...	34	6	6	22	76	26	23	27	412	135	100	177
Welsh	—	—	—	—	—	—	—	—	—	—	—	—
Totals ...	283	40	120	123	564	94	274	196	4,890	973	2,067	1,850

* 19 Candidates took the Oral Examination in French. 2 passed with Distinction, 12 Passed and 5 Failed.

† In Shorthand, First- and Second-class in the Senior School Commercial Certificate Examination represent speeds of 100 and 80 words per minute respectively. In the School Commercial Certificate Examination the figures in the Passed with Credit column represent a speed of 60 words per minute, and those in the Passed column a speed of 50 words per minute.

[The above details do not include the papers worked in Jamaica, which have not yet been received. 567 papers in the Senior School and 495 in the School Examination are awaited.]

Details of the Ordinary (Single Subject) Examinations, 1947 (including Autumn Series, 1946)

Subjects	Stage III.—Advanced				Stage II.—Intermediate				Stage I.—Elementry				Total number of Papers worked in all Stages	
	Papers worked	1st-class Certificates	2nd-class Certificates	Not Passed	Papers worked	1st-class Certificates	2nd-class Certificates	Not Passed	Papers worked	Passed with credit	Passed	Not Passed	1947	1946
Accounting	63	7	26	30	—	—	—	—	—	—	—	—	**63**	56
Advertising	6	1	4	1	—	—	—	—	—	—	—	—	**6**	—
Arithmetic	123	32	57	34	1,071	250	372	449	3,692	1,002	1,403	1,287	**4,886**	5,366
Book-keeping	554	49	240	265	2,476	620	981	875	6,867	1,499	2,761	2,607	**9,897**	9,002
Commerce	57	4	36	17	270	10	178	82	863	53	480	330	**1,190**	1,249
Commercial Law	18	4	14	—	122	33	55	34	—	—	—	—	**140**	123
Common Law	8	—	6	2	—	—	—	—	—	—	—	—	**8**	4
Company Law	17	5	10	2	35	6	13	16	—	—	—	—	**52**	44
Costing	31	—	14	17	56	9	25	22	—	—	—	—	**87**	40
Danish	—	—	—	—	—	—	—	—	12	6	4	2	**12**	—
Dutch	—	—	—	—	—	—	—	—	12	5	7	—	**12**	11
Economic Geography	12	1	8	3	212	32	110	70	525	35	211	279	**749**	713
Economic and Social History	5	3	1	1	47	2	19	26	—	—	—	—	**52**	32
Economic Theory	51	4	34	13	211	17	137	57	—	—	—	—	**262**	237
English	510	38	340	123	1,720	112	852	756	3,900	272	2,426	1,202	**6,130**	6,572
Esperanto	21	6	13	2	31	9	16	6	55	15	15	25	**107**	110
French	263	30	113	120	583	134	244	205	1,431	255	673	503	**2,277**	2,212
German	51	21	20	10	149	41	59	49	138	37	48	53	**338**	341
History	—	—	—	—	—	—	—	—	76	9	38	29	**76**	291
History of the British Empire	3	—	2	1	9	—	3	6	7	1	5	1	**19**	42
History of the U.S.A.	3	—	2	1	9	5	3	1	14	6	7	1	**26**	9
Italian	5	2	2	1	17	2	14	1	32	10	14	8	**54**	74
Law and Practice of Marine Insurance	10	1	9	—	—	—	—	—	—	—	—	—	**10**	9
Norwegian	—	—	—	—	5	5	—	—	22	21	1	—	**27**	12
Polish	—	—	—	—	11	—	8	3	11	1	9	1	**22**	13
Public Administration	14	5	6	3	—	—	—	—	—	—	—	—	**14**	20
Real Property and Conveyancing	14	4	5	5	—	—	—	—	—	—	—	—	**14**	3
Russian	8	3	2	3	64	12	32	20	98	29	41	28	**170**	155
Shipping Law and Practice	5	—	4	1	—	—	—	—	—	—	—	—	**5**	15
Spanish	15	9	5	1	102	43	45	14	269	125	96	48	**388**	355
Stock Exchange Law and Practice	—	—	—	—	12	3	5	4	—	—	—	—	**12**	17
Swedish	—	—	—	—	5	1	3	1	14	2	3	9	**19**	2
Typewriting	2104	373	826	905	7,109	2,036	2,437	2,636	11,546	3,785	3,356	4,405	**20,759**	18,215
Totals, **1947**	**3,971**	**602**	**1,808**	**1,561**	**14,326**	**3,382**	**5,611**	**5,333**	**29,584**	**7,168**	**11,598**	**10,818**	**47,881**	
1946	3,570	642	1,618	1,310	12,671	3,050	4,801	4,820	29,103	7,171	11,695	10,237		45,344

Shorthand	Papers worked	Passed	Not passed
140 words per minute	208	117	91
100 " "	2,673	1,857	816
60 " "	3,969	2,643	1,326
60 " " (typed transcript)	123	86	37
Shorthand-Typist's Certificate—			
Totals, **1947**	161	104	57
" 1946	141	106	35
Junior Shorthand-Typist's Certificate—			
Totals, **1947**	453	299	154
" 1946	269	183	86

Shorthand	Papers worked	Passed	Not passed		
120 words per minute	1,222	620	602		
80 " "	6,698	4,054	2,644		
50 " "	5,367	2,638	2,729		
50 " " (typed transcript)	116	46	70	**20,376**	16,957

Total of Papers worked, 1947 (Ordinary Examinations):—

Shorthand	20,376
Shorthand-Typist's Certificate	161
Junior Shorthand-Typist's Certificate	453
All other subjects	47,881
	68,871

To the total of 68,871 papers worked at the Ordinary Examinations in 1947 should be added (1) 5,734 at the Senior and School Examinations (2) 5,366 at the Grouped Course Examinations; (3) 1,237 at the Transport Examinations; (4) 398 at the Oral Tests; (5) 117 at the examination in English for Dutch Students, making a total of 81,723. In addition, about 1,300 papers are awaited from overseas centres.

MODERN ASTRONOMICAL INSTRUMENTS

By Sir HAROLD SPENCER JONES, M.A., SC.D., F.R.S., *Astronomer Royal*

TRUEMAN WOOD LECTURE

Twenty-second Ordinary Meeting, Wednesday, May 28th, 1947

The Right Hon. VISCOUNT BENNETT, K.C., P.C., LL.D., President of the Society, *in the Chair*

THE CHAIRMAN: A very great honour devolves upon me this afternoon—that of introducing to you the Astronomer Royal of this Kingdom. He tells me that he is the tenth to hold this appointment since 1665; so you can see this post provides the best of insurance policies for long life and security.

Without further words, I have great pleasure in asking Sir Harold Spencer Jones to speak to us on Modern Astronomical Instruments.

Sir HAROLD SPENCER JONES then read the following paper:

The main trend of modern astronomical telescope design has been conditioned to a large degree by the demand of astronomers for greater and greater light-gathering power. The development of the large reflecting telescope, which forms the principal instrument of most observatories to-day, will therefore provide the main subject of my discourse. But in recent years new types of instruments have been designed for special purposes, and have made important contributions to astronomy. For the sake of a proper perspective mention must be made of some of these.

Before the invention of the achromatic lens about the middle of the eighteenth century, increase in aperture was possible only by increase in focal length. Telescopes became long and unwieldy, sometimes exceeding 200 feet in length. Attention was therefore diverted to the reflecting type of telescope. The early mirrors were made of speculum metal, a hard brittle alloy of copper and tin containing about one part, by weight, of tin to two of copper. Speculum metal will take a high degree of polish and has a moderately high reflecting power, which drops from about 70 per cent. in the red to 50 per cent. in the violet. The metal is difficult to cast and anneal, unless the copper content is increased, and then the mirror is liable to tarnish. The tarnish can only be removed by repolishing and refiguring.

Considerable improvements in the construction of speculum mirrors were made by William Herschel in the latter part of the eighteenth century. His two most famous telescopes were the 20-foot telescope of 19-inch aperture and the great 40-foot telescope of 48-inch aperture. The mounting of these telescopes was of the altazimuth type; the telescope was suspended between two wooden frameworks and was raised or lowered in altitude by means of ropes and pulleys, whilst the whole mounting could be turned in azimuth. They must have been extremely inconvenient to use. The many important discoveries made with them by Herschel are a tribute not only to the quality of his optical work but also to his skill and assiduity as an observer.

The development of the achromatic objective brought the refracting telescope back into favour, especially after Fraunhofer, who had learnt from the younger Guinand how to make glass, succeeded in casting several disks of glass of excellent quality and in making lenses from them, computing the curves himself. So complete

was the reversion to this type of telescope that Lord Rosse wrote in 1828 "Many practical men whom I have spoken to seem to think that since Fraunhofer's discoveries the refractor has entirely superseded the reflector and that all attempts to improve the latter instrument are useless".

Lord Rosse did not accept this view and he himself made great improvements in the technique of casting and polishing specula. His great reflector, with a speculum mirror of 6-foot aperture and of 53-foot focal length, was completed in 1851. The motion of the telescope was limited to about one hour on either side of the meridian,

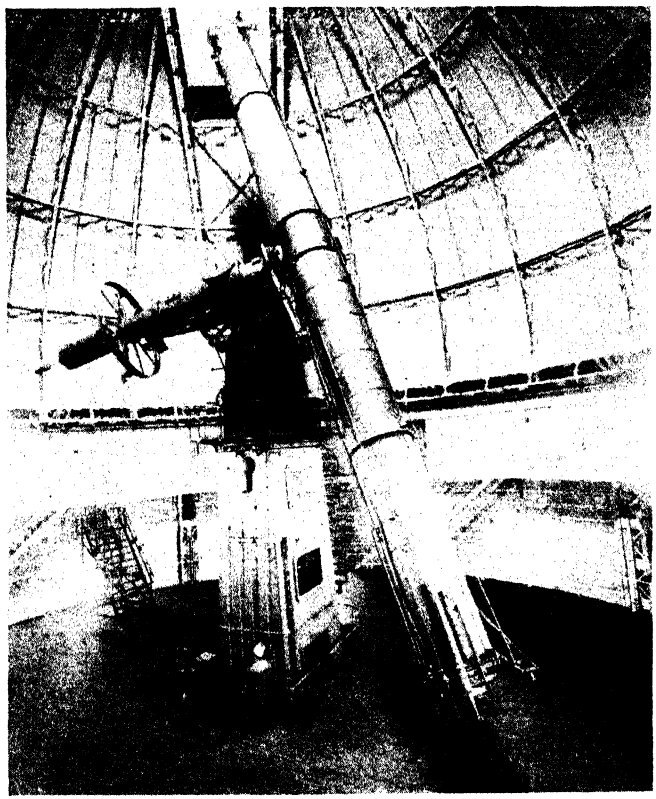


FIG. 1.—*The 40-inch refractor of the Yerkes Observatory*

two solid walls of masonry being used for its support. This telescope had the distinction of having for the first time revealed the spiral structure of the spiral nebulæ. More than sixty years were to elapse before a telescope of greater light-gathering power was constructed.

The invention of the equatorial type of mounting greatly facilitated observations with telescopes of the reflecting as well as of the refracting type, and the altazimuth mounting became obsolete. In order to be able to point to any desired part of the sky a telescope must have two degrees of freedom. If its motions are in altitude and azimuth, motion about each of its axes is necessary in order to keep an object in the

field of view. In the equatorial mounting, the telescope can be turned about an axis (called the polar axis), which is parallel to the axis of the earth, and about an axis perpendicular to this. When the telescope is set upon a star, a uniform rotation of the polar axis at the rate of one revolution per sidereal day is all that is necessary to keep the star stationary in the field of view. This uniform continuous rotation can be given by clockwork controlled by a governor, or, where an alternating current supply of properly regulated frequency is available, by synchronous motor.

For a time attention was concentrated mainly on the refracting telescope, despite Lord Rosse's advocacy of the reflector. A 15-inch refractor was considered a large telescope in the first half of the nineteenth century. The 25-inch refractor of 30-foot focal length, built by Cooke for R. S. Newall at Gateshead, and by him given to Cambridge University in 1889, was the largest telescope of its day. The desire for greater and greater light-gathering power led to still further increases in size, culminating in the 36-inch refractor of 58 feet focal length of the Lick Observatory, constructed in 1888, and the 40-inch refractor of 63½ feet focal length of the Yerkes Observatory, constructed in 1897. Both of these objectives were made by Alvan Clark, the mountings being made by Warner and Swasey. No refracting telescopes of greater aperture have been or are likely to be made. Disks of optical glass of so great a size, free from strains, striations, veins and other troublesome defects, are extremely difficult to cast. Moreover, as the lens can only be supported at the rim, the impossibility of eliminating flexure imposes a practical limitation on the size. In order to keep optical aberrations within reasonable limits, the focal length must be great; the telescope becomes unwieldy in use, while a very large building and dome are required for housing it.

The long focus refractor is valuable for certain specific purposes. It gives good images over a flat field of moderate extent. For a focal length of 25 feet the diameter of useful field is about one degree; it varies approximately in the inverse proportion of the focal length. The focus is not subject to rapid changes with temperature. The refractor is consequently a good instrument for precise and accurate measurement, either by visual or photographic methods. Observations of close double stars can best be made with a long-focus refractor and practically all modern determinations of stellar distances have been made with refractors of focal length from 22½ feet upwards. The refractor has some disadvantages however. For photographing faint extended objects, such as nebulæ or comets, a large-aperture ratio is required. The aberrations of a lens system of a given type increase with the aperture ratio; the larger the aperture ratio the more complicated the system must be. The absorption of light in the lens increases with the complexity and so also does the expense. Complicated lens systems of large aperture have never been constructed. It is not possible for a lens to bring light of all colours to the same focus. If the telescope is designed for visual observation, the objective is corrected for the region of the spectrum to which the eye is most sensitive, about 5,500 A. The image of a bright star shows a purple halo round the focussed yellow image due to the out-of-focus light, secondary spectrum, as it is called. Telescopes designed for photographic observation are corrected for the blue-violet region of the spectrum, giving a minimum focus about 4,340 A. As most observations are now made photographically, visual refractors have been adapted for photography by using yellow-sensitive or

orthochromatic plates in conjunction with a yellow filter to eliminate the poorly focussed blue light.

The refracting telescope having reached a practical limit in size and aperture, the astronomer has necessarily reverted to the reflecting telescope; for greater light-gathering power all large-aperture telescopes built in the last fifty years have been of this type. The development of the silver-on-glass mirror, which avoided the difficulties inherent in the use of speculum metal, began to bring the reflecting telescope back into favour in the seventies and eighties of the last century. The discovery of a simple chemical process by which a thin film of silver could be deposited on a glass surface was due to Leibeg; the application of this discovery to glass mirrors and the methods of making and testing such mirrors were due primarily to Foucault in the sixties of the last century. A freshly prepared silver film has a high reflectivity, exceeding 90 per cent. throughout the visible spectrum. On the short wavelength side of 4,500 A., however, the reflectivity falls at first slowly and then rapidly to a minimum value at about 3,200 A. A silver film is practically transparent to light of this wavelength. The silver film suffers from the disadvantage that it tarnishes easily. On the other hand, the film can be easily replaced without any injury to the figure of the mirror by direct chemical deposition. Until recent years all modern reflecting telescopes employed silver on glass mirrors. The silver film is now becoming obsolete, and an aluminium film is used instead. The aluminium is deposited by a process of vacuum distillation at a pressure of about 10^{-5} mm. of mercury. The coating has a reflecting power which is nearly as high as that of freshly deposited silver throughout the visible spectrum and does not show the severe drop in reflectivity of the silver film near 3,200 A. Between 3,250 A. and the limit of atmospheric transmission at about 2,900 A. the aluminium film has very marked advantages over silver for astronomical investigations. The film does not tarnish. It adheres strongly to the glass surface, and is hard, so that it can be cleaned with soap and water. Under favourable atmospheric conditions the film will last for several years. All large reflecting telescopes now used aluminized mirrors and it is intended to aluminize the 200-inch mirror when it has been completed.

Glass is far from an ideal material for supporting the reflecting film, but a more suitable material has yet to be found. The surface of the disk has to be given the figure of a paraboloid, so that light parallel to the axis is brought accurately to a focus and axial images are free from spherical aberration. The mirror is first ground and polished to a spherical shape. The process of parabolizing then involves the progressive reduction in the radius of curvature from the edge to the centre. The amount of material to be removed in this important stage is extremely small; in the case of the new 200-inch mirror it amounts to a maximum of 1/500th-inch at the centre of the mirror. In the 100-inch mirror of the Mount Wilson Observatory the actual curve of the glass nowhere differs from the correct theoretical curve by more than .000003-inch. It is obvious that the material used for the mirror must not have the least tendency to warping or distortion with age. In this respect glass has proved to be entirely satisfactory.

What are the other requirements? Since the mirror has to be mounted in a telescope which is housed in a dome, it is subject to changes of temperature. It is desirable, therefore, that the material should have a high conductivity for heat and

not too high a coefficient of expansion. The poor conductivity for heat of glass and its relatively large coefficient of expansion have a twofold disadvantage. The disk, after being cast, must be subject to a slow annealing process, during which at any stage the temperature throughout the mass is practically uniform in order to relieve internal strains; if the annealing process is too long continued, on the other hand, there is a risk of devitrification. In the second place, the glass disk cannot respond quickly to rapid changes of temperature; the temperature becomes non-uniform through the disk with consequent distortion of figure and impaired images. The material of which the mirror disk is made should be capable of taking a high polish, should have great rigidity, should be easy to cast and anneal, and should be relatively light. High reflecting power is immaterial, if an aluminium film can be successfully deposited on the polished surface. Speculum metal fails on the score of its great weight; it is difficult to cast, and nothing is really known about its permanence of figure. It is possible that there may be some metallic alloy which would be free from any effects of ageing and distortion, have great rigidity, and be relatively light; if the rigidity was high, the weight could be reduced by decreasing the thickness of the mirror and stiffening it by a suitable webbed or honeycomb structure on its back surface. Unfortunately practically nothing is known about the ageing effects of metallic alloys to the high degree of precision with which the astronomer is concerned. Invar pendulum rods have been found at Greenwich Observatory to increase their length slowly and progressively over a period of at least a dozen years. Astronomers are therefore nervous of using any metallic alloy unless permanence of figure can be guaranteed. Metallurgists, on the other hand, have not been concerned with the high degree of precision which the astronomer needs, and are unable to guarantee that any alloy will meet requirements. Although, therefore, alternatives to glass have been considered, the astronomer has always returned in the end, *faute de mieux*, to glass.

When the construction of the 200-inch telescope was decided upon, the use of some material for the mirror less unsuitable than glass was considered. As fused quartz has a very much lower coefficient of expansion than glass, experiments were carried out with the fusing of grains of quartz together on to a facing of clear fused quartz and so building up a large disk. The process was found to be feasible, but altogether too expensive for a very large mirror. The next most suitable material appeared to be the glass of high silica content, known as pyrex, whose coefficient of expansion is only about one-third of that of plate glass. A special pyrex, with a still higher silica content and a coefficient of expansion about 15 per cent. less than that of ordinary pyrex, was eventually decided upon.

The usual method of casting large mirrors had been to pour the molten glass into an open mould, the furnace being tapped and the glass running from a trough into the mould. The 100-inch disk was made this way, with two pourings. The interface between the pourings contained many bubbles and defects and the disk was at first rejected, but several attempts to make a better disk failed in the annealing. Special pyrex glass cannot be poured in the same way as plate glass; it soon chills sufficiently to stop the flow. A new technique for casting therefore had to be devised.

A solid glass disk 200 inches in diameter and 30 inches in thickness would have weighed about 40 tons. It was therefore decided to reduce the weight by constructing

a disk with a thin face supported on a ribbed back, the ribs being arranged to provide adequate stiffness. For casting the disk, a mould was built up with ceramic cores, bolted down to a baseplate, to provide the ribbed back. A bee-hive shaped casting chamber was placed over the mould, which was heated electrically from beneath, while gas torches around the sides supplied heat during the pouring, the chamber being maintained at a temperature of 2,400°F. The ingredients of the glass, called batch, were fed into one end of the melting tank, where the temperature averaged 2,730°F. At the "working end" of the tank, where the glass was withdrawn, the temperature was about 30° lower. The molten glass was taken from the melting tank to the casting chamber by iron ladles, capable of holding 400 lb. of glass. Three

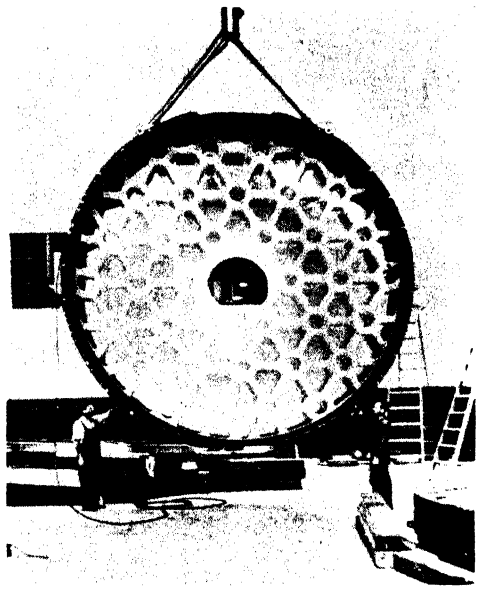


FIG. 2.—*200-inch glass disk showing honeycomb structure*

ladles were used, which were conveyed along by overhead tracks to three pouring gates in the casting chamber. After withdrawing the ladle from the tank it was rapidly chilled on the outside by spraying with water under pressure from a ring feed. About one-third of each ladle was poured into the mould, the remainder being emptied into an iron wheelbarrow and returned to the melting end of the tank. The casting process lasted 10 hours, 300 pourings being required. After the casting was completed, the temperature was progressively decreased during several days to 1,200°F. The disk with its insulated bed was then lowered from the casting chamber on to a special truck, so that it could be run along a specially prepared track until it was beneath the annealing oven; it was then hoisted up into position in the oven. The annealing oven was heated electrically by some 300 heating elements, the temperature being automatically controlled by a special control panel and gradually lowered as the annealing progressed. The annealing extended over ten months, and

subsequent tests showed that the disk was free from internal strains—it was calculated that if the disk had been made of ordinary plate glass it would have been necessary to extend the annealing over nine years.

The mirror must be mounted in the telescope in such a way that, in whatever position the telescope may be placed, there is no danger of the slightest distortion through flexure. A satisfactory method of support was designed by Ritchey for the Mount Wilson 60-inch mirror, and a similar method was used for the 100-inch mirror. The mirror is supposed to be divided into twelve segments of equal weight. Three circular flat plates, whose lower surfaces are spherical and fit into spherical sockets, form the primary support, bearing on three equidistant outer segments. The weight of each of the remaining nine segments is balanced by means of a weighted lever, suspended between pivots screwed through lugs connected to the cell; each lever arm is counterpoised so as to press against the back of the mirror with a force exactly equal to the weight of one segment. The lateral position of the mirror is rigorously defined by two metal arcs; two other arcs, diametrically opposite, are pressed against the mirror by weak springs. The weight of the mirror, when in an inclined position, is carried by a counterpoising ring, completely encircling the edge of the mirror. The ring is pressed against the edge of the mirror by a system of short weighted levers. It was found in actual use that, when the 100-inch mirror was turned from one position to another, tangential strains caused some deterioration in the quality of the star-images. The mirror was therefore remounted with pads fitted to its back, which were supported by ball bearings on the counterpoised pads; the tangential strains were thus eliminated and the quality of the images was improved.

For the 200-inch mirror a different method of support has been designed, taking advantage of the ribbed system at the back of the disk. The ribbing or honeycomb structure contains 36 cylindrical pockets, lying on five concentric circles, each pocket being connected to all the adjacent pockets by a glass rib. These 36 pockets have been ground accurately cylindrical, with axes perpendicular to the plane of the back face. In each pocket is fitted a steel sleeve, gaskets being inserted between its bearing faces and the glass. This sleeve is connected to the cell frame by an integral two-component system of balance weights and levers, the counterpoises being designed to compensate the weight carried by each unit. Double gimbal gearings on the steel sleeve and on the support fixed to the cell frame prevent constraints. Three of the lever systems are tied down by circumferential springs to constrain the disk against rotation about the axis, while three others are tied down as axial defining points. A central steel tube passes through the 40-inch diameter central hole in the mirror; four centre radial jacks, made of invar and steel to compensate for expansion of the central steel tube, define the radial location of the mirror, no edge band being required. These centre jacks and 12 edge radial squeeze arcs, to remove gravitational astigmatism, are provided with ball bearing faces to allow freedom in the plane normal to the applied reaction. This complicated support and position defining system is necessary to ensure that no deformation of the optical surface occurs, whatever the position of the mirror, which in its completed form weighs 15 tons.

Three different types of mounting for large telescopes are commonly used. In one type the polar axis is supported by a pier at each end, the telescope being mounted

at the side of the polar axis on a cross axis called the declination axis, and counterpoised by a suitable weight at the other end of the axis. This mounting is used in the Victoria 72-inch and the Toronto 74-inch reflectors. Ball or roller bearings are used to take the radial and axial thrusts. The disadvantage of this type of mounting is that if a long exposure, extending over meridian transit, is to be given, the telescope must be swung over from one side of the pier to the other. In a second type of mounting, used for the Mount Wilson and Harvard 60-inch reflectors, the polar axis is short and carries at its upper end a short stiff fork, in which the telescope is hung. It is proposed to mount the new Lick 120-inch reflector in this way; in order to avoid troublesome flexures, the fork will be made of immense strength.

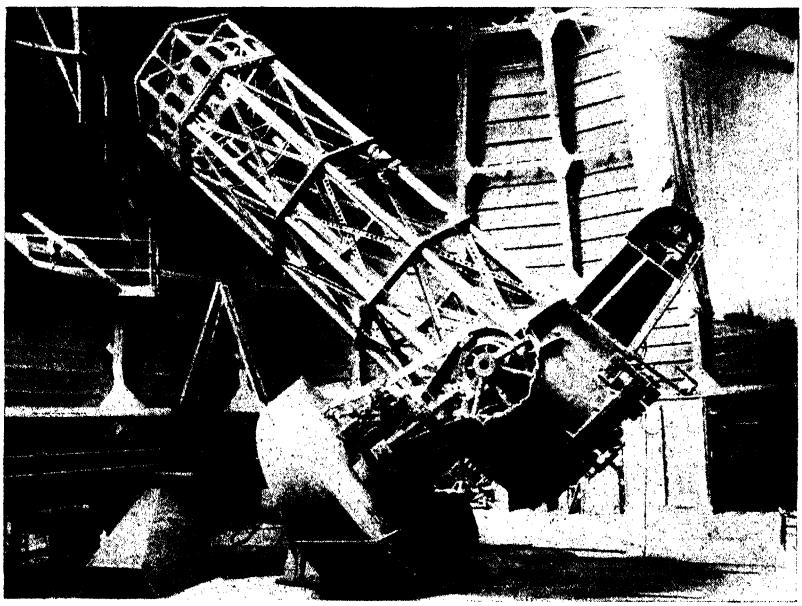


FIG. 3.—*The 60-inch reflector of the Mount Wilson Observatory*

In a third type of mounting, used for the Mount Wilson 100-inch reflector, the polar axis is supported at both ends, but is in the form of a cradle, the telescope being carried on a short axis, mounted in the cradle. In the Mount Wilson 100-inch reflector, friction is relieved by a mercury flotation system at both ends of the polar axis. The disadvantage of this form of mounting is that the telescope cannot be used on a portion of the sky around the pole. This disadvantage is avoided in the modified form of mounting used for the 200-inch reflector, the upper bearing being in the form of a stiff open horseshoe-shaped girder, 4 feet wide and 46 feet in outside diameter. The telescope can lie in the throat of the horseshoe, pointing directly to the north pole.

Some particulars about the 200-inch reflector may be of interest as illustrating the engineering problems involved in the design and construction of a large telescope. The telescope "tube" is in the form of a rigid hollow square centre-section, with

a strong rigid ring at each end. Each ring is attached to the central section by eight stiff 20-inch diagonal I beams, forming four triangles whose bases are the sides of the square and whose apices are on the ring. The lower ring carries the mirror and cell, weighing 35 tons; the upper ring carries a cage, which supports the housing for the auxiliary mirrors, weighing 30 tons. The design gives great rigidity, and, due to the geometrical construction, the differential flexure is small, so that the primary and secondary mirrors remain parallel to one another to a high degree of accuracy. The tube, excluding the mirror cell and upper cage, is 22 feet square, 44 feet long, and weighs 75 tons. It was constructed mostly of steel plates, welded together, each

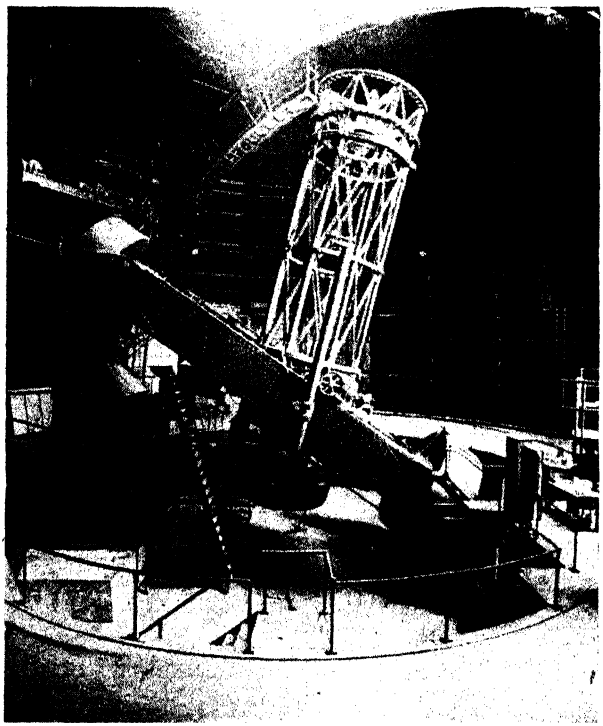


FIG. 4.—*The 100-inch reflector of the Mount Wilson Observatory*

section being annealed at 1,150°F. to relieve strain. The mirror cell is a cylindrical box of welded steel strongly braced for strength and stiffness. It is nearly 20 feet in diameter and weighs 19 tons. The upper cage, to carry the cylindrical housing with the auxiliary mirrors and observer, is 22 feet in diameter and 12 feet high.

The horseshoe bearing, 46 feet in diameter and 4 feet thick, is 12 feet wide at the throat, tapering to nothing at the ends. A complicated system of internal bracing gave the necessary stiffness. All the parts were welded together without the employment of a single rivet. The outer bearing rim was made of special steel plate, 4½ inches thick. The total weight of the horseshoe was about 170 tons and it contained nearly a mile of welded seams. Some deformation of the horseshoe as the telescope was turned was unavoidable. It amounted only to one-twentieth of an

inch at the tip of its horns, but this would be sufficient to upset the collimation of the mirrors. The effects of this deformation were eliminated by pulling the horns together with a turn-buckle, exerting a tension of 130 tons, and inserting a spreader in the throat, which exerted an outward push of 225 tons. Thus distorted, the bearing surface was milled and polished so as to be truly cylindrical to an accuracy of .003 inch, this task taking 3,000 working hours. When the spreader and turn-buckle were removed, the horns sprang slightly apart. The effect of deformation as the telescope turns is merely to counteract the distortion thus artificially introduced. The thrust bearing at the lower end of the telescope is of the ball and cup type, in

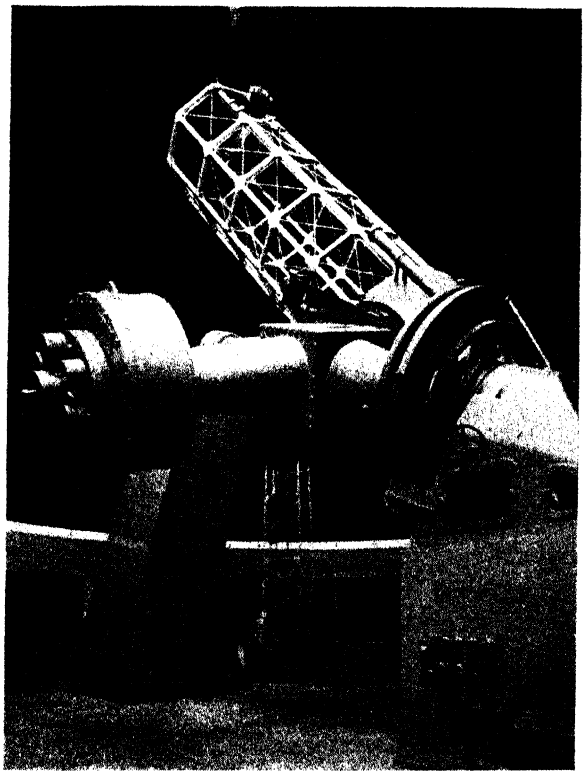


FIG. 5.—*The 74-inch reflector of the Radcliffe Observatory at Pretoria. View from North-West*

the form of a hemispherical shell of steel, 7 feet in diameter. The upper and lower bearings are connected by the yoke, consisting of two side arms in the form of hollow cylinders, 47 feet long and 10 feet in diameter, made of 1 inch steel plates welded together. These arms are attached at their upper ends to the horseshoe and at their lower ends to a crosspiece in the form of a bent box-girder, 46 feet long and 11 feet deep, which carries the hemispherical bearing, and is stiffened with many internal stiffeners.

The total moving parts of the telescope weigh 450 tons. In order that the telescope should move smoothly and easily, it was essential that friction at the bearings should be reduced to a minimum. The large horseshoe is supported by two oil-pad

bearings, each 28 inches square and faced with Babbitt metal. The hemispherical thrust bearing at the lower end rests on three oil-pads. Oil is forced through a central hole in each of the pads under a pressure of 250 lb. The pressure is sufficient to force the oil outwards from the hole towards the outer edges of the pads, whence it returns to the pump. The telescope thus floats on a film of oil.

The modern large reflector is more compact than a large refractor, as the mirror usually has an aperture ratio of $f/5$ or even of $f/3.3$. But, when it is used in the Cassegrain manner, different convex mirrors can be employed, giving different equivalent

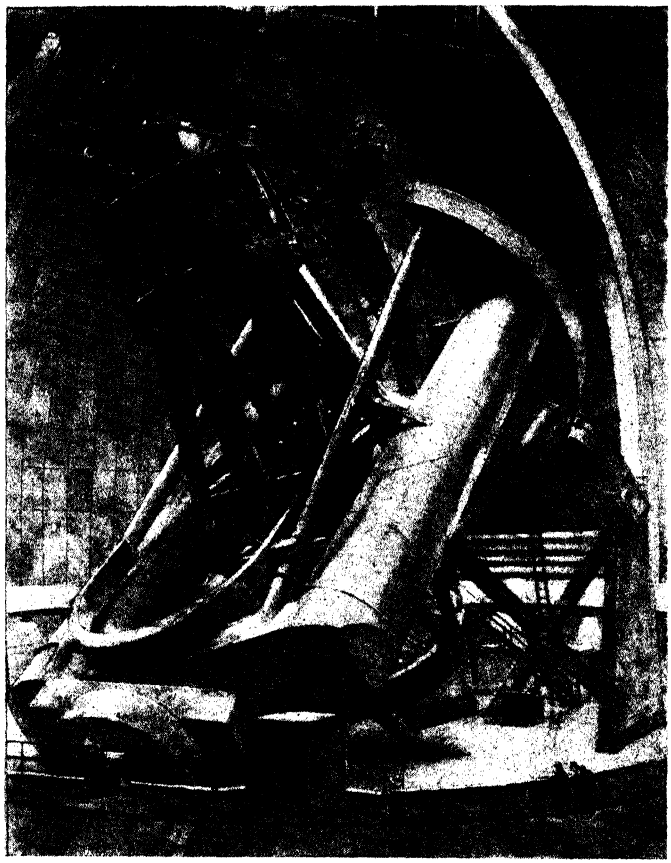


FIG. 6.—*The 200-inch reflector at Mount Palomar*
(From the drawing by R. W. Porter)

focal lengths. Thus, for instance, a 5-foot reflector may have a focal length of 25 feet, for observations at the primary focus. It may also be used as a Cassegrain for direct photography or for spectroscopic observations at a secondary focus near the lower end of the tube, with an equivalent focal length of 87½ feet. By changing the Cassegrain mirror and intercepting the converging beam on the polar axis by a mirror, geared to turn in declination at half the rate of the telescope, the beam may be thrown down a hollow polar axis to a fixed focus, suitable for employing a large, massive and powerful spectroscope. The equivalent focal length in such an

arrangement may be, say, 125 feet. The 200-inch mirror has been figured to a focal ratio $f/3.3$, corresponding to a focal length of 50½ feet. The Cassegrain combination works at $f/16$, giving an equivalent focal length of 267 feet. The Coudé combination works at $f/30$, giving an equivalent focal length of 500 feet. The $f/16$ Cassegrain combination can be used in two ways. The main Cassegrain focus is just below the central hole in the main mirror. At this focus either direct photographs can be made or a spectrograph may be used for spectrographic observations. Instead, however, of converging to this focus, the light can be reflected by a diagonal flat mirror, placed at the intersection of the two axes of the telescope, and thrown through one or other of the hollow declination trunnions into the 10-foot diameter yoke tube, where an 8-foot plane-grating is mounted. There are steps inside the yoke tube, which the observer mounts, making observations at this focus from within the tube. The various auxiliary mirrors are all mounted in the housing at the top of the telescope tube and any particular mirror can be swung into correct position in a few moments.

The parabolic reflector is free from the defects of chromatic and spherical aberration, but at small distances from the axis the images are badly affected by coma, the amount of which is proportional to the distance from the axis, and by astigmatism, the amount of which is proportional to the square of the distance. The amounts at different axial distances, for two different aperture ratios, are as follows:

Aperture ratio	*Field diameter (degrees)*	*Astigmatism (seconds of arc)*	*Coma (seconds of arc)*
$f/10$	0.5	0.4	1.7
	1.0	1.6	3.4
	2.0	6.3	6.8
	4.0	25.2	13.6
$f/3$	0.5	1.3	18.7
	1.0	5.2	37.4
	2.0	21.0	74.9
	4.0	83.8	149.8

For spectrographic observations, these defects are immaterial, as axial images are used; for photoelectric observations they are relatively unimportant, as we are then concerned primarily with the total amount of light and not very much with its concentration into a sharp image. But for all purposes involving direct photography, such as stellar photometry, studies of stellar distribution, galactic structure and so on, the small field of good definition imposes severe restrictions. In order to overcome the coma and enlarge the usable field, Ross has designed special correcting lenses of zero power to be placed in the converging beam near the focus. The corrector has negative coma equal to the positive coma of the paraboloid, but this correction is made only at the expense of reintroducing spherical aberration. For the 200-inch telescope two correcting lenses have been designed. The first of these is intended for use under the best conditions of seeing and will have a spherical aberration confusion disk of 1″.5 diameter, and will increase the area of the field of good definition tenfold. The second is intended for use under average conditions of seeing and will have a spherical aberration confusion disk of 2″.5 diameter. It will increase the area of good definition some twenty- or thirty-fold.

Various modified designs of reflecting telescope have been devised to reduce the effects of coma, the most ingenious being that known as the Schmidt telescope, designed by Bernhard Schmidt in 1930. Schmidt pointed out that a spherical mirror, unlike a paraboloid, has radial symmetry. If a diaphragm is placed at the centre of curvature any parallel bundle of rays will be focussed into a circle of confusion about half-way between the centre of curvature and the mirror. The spherical aberration is constant over the whole field. For an aperture ratio of *f*/ 10 and at the best position for focus it amounts only to 1.6″ and the paraxial images, even with a plane plate, are better than with a paraboloid. But as spherical aberration increases in proportion to the third power of the aperture ratio it amounts for an aperture ratio of *f*/ 3 to 60″. Schmidt remarked that if a thin glass plate were placed in contact with a spherical mirror, the process of parabolizing could be replaced by giving a slight variation in thickness of the glass plate. This would not result, of course, in any better optical performance than the paraboloid. If, however, the glass plate is placed at the centre of curvature and deformed aspherically by figuring in the right way, the same result is achieved, but the mirror is, in effect, parabolized in every direction at once, because of the radial symmetry. A large field of sharp focus is then obtained, free from the defects of spherical aberration, coma and astigmatism. The focal surface is not flat, however, but lies on a sphere whose radius is the focal length of the system. The photographic plate or film must consequently be curved to fit this surface precisely. Some chromatic aberration is introduced if the correcting plate is made of a single variety of glass; if full correction is obtained in the yellow, there will be over-correction in the blue and under-correction in the red. The colour error is, however, small except at extreme aperture ratios, such as *f*/ 0.6, and can be eliminated, if desired, by constructing a paired correcting plate of crown and flint, both deformed from a sphere. Because the correcting plate is so nearly flat, Schmidt telescopes can be used at very large aperture ratios. At *f*/ 1 a useful field of 25° can be obtained. In order that the images at the edge of the plate may be formed by beams which are not partially cut off, the diameter of the mirror must exceed that of the free aperture (the diameter of the correcting plate) by twice the photographic plate diameter. Thus, when reference is made to a 24-36-inch Schmidt telescope, it implies that the correcting plate has an aperture of 24 inches and the mirror of 36 inches—the photographic plate used in such a telescope can have a diameter of 6 inches.

The Schmidt telescope enables a large aperture ratio to be used, and has a large field of good definition and high speed. It is an ideal telescope for stellar photometry and for the study of stellar distribution. Its chief defect is that the tube-length must be twice that of a parabolic telescope of equal focal length. But as with a 36-inch mirror at *f*/ 3 the tube length is only 18 feet, this is not a serious disadvantage, for in its normal form a parabolic telescope of this aperture would probably be constructed to work at *f*/ 5, giving a tube length of 15 feet, because the effects of coma would be serious at *f*/ 3.

Various modifications of the Schmidt design have been proposed. In 1931, Maksutov of the State Optical Institute, Leningrad, found that the aspherical correcting plate of the Schmidt system could be replaced by a thin sharply-curved negative meniscus lens, whose surfaces are nearly concentric with the surface of

the spherical mirror. The spherical aberration of the mirror is corrected by that of the negative meniscus lens and the system is nearly completely achromatic. The aberrations do not increase off the axis because of the spherical symmetry and the system is free from coma and astigmatism. It thus provides a large highly corrected field of view, even at low f-numbers. As compared with the Schmidt system, the Maksutov system has two advantages: it employs only spherical surfaces and, for a given aperture, the tube length is considerably shorter because the correcting lens

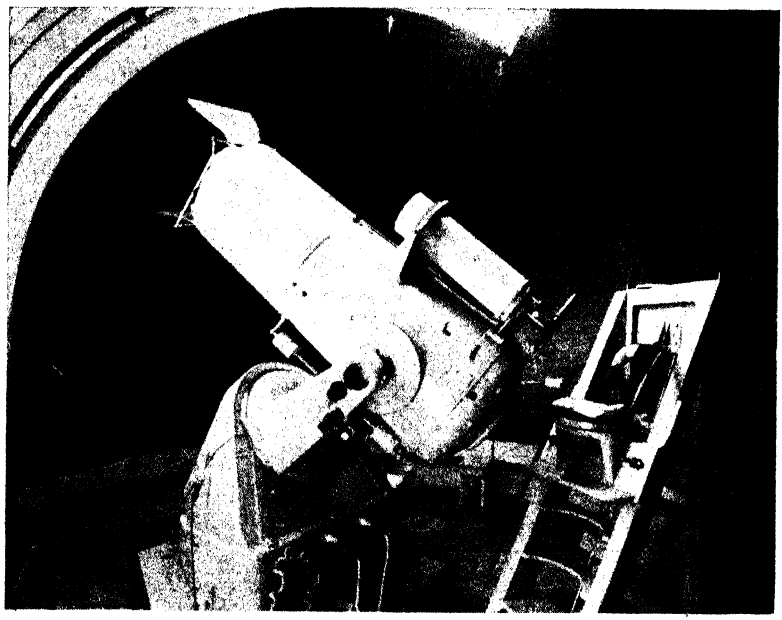


FIG. 7.—*The 18-inch Schmidt Camera at Mount Palomar*

is not far in front of the focus. Great care is needed in correctly mounting the meniscus lens and, as in the Schmidt system, the focal field is curved.

A different modification was designed by Wright in America, which avoids the inconvenience of the curvature of the field, but at the cost of complete symmetry. Wright combines a correcting plate immediately in front of the primary focus with an oblate spheroidal mirror. The combination is free from spherical aberration and coma, but the field is limited in comparison with the Schmidt because of the astigmatism off the axis. The system also presents greater difficulties in construction. The colour error of the correcting plate is double that of a Schmidt system of equal speed. The Wright system has a flat field and a short tube length, but should not be used at a greater aperture-ratio than $f/3$. Various other modifications of the Schmidt system have been proposed, such as Hawkins and Linfoot's combination of an aspherical plate at the centre of curvature and a meniscus lens concentric with the mirror surface—providing a combination of the Schmidt and Maksutov system. These examples of modifications of the original Schmidt design have all developed from the fundamental idea of correcting the aberrations of the primary mirror by a separate component. The astronomer who wishes to design a telescope for a particular purpose now has available a considerable variety of alternatives from which to choose.

Coming now to more specialised fields of observation, two instruments have been designed within recent years which have proved of great value in observations of the sun. Let me first recall the principle of the spectro-heliograph, an instrument invented independently by Hale and Deslandres in 1890. By means of a coelostat and lens, light from the sun is brought to a focus on a narrow slit lying across the circular image of the sun. The light passing through the slit is collimated by a concave mirror and reflected as a parallel beam on to a reflection grating. The dispersed beam reflected from the grating falls on a second concave grating and is focussed into a spectrum in the plane of a second slit. By tilting the grating, light of any desired wavelength can be brought on to the slit. The light passing through this slit is merely an image in the chosen narrow spectral band of the portion of the solar image on the first slit. A photographic plate is placed immediately behind the second slit. The first and second slits are driven across the solar image at a uniform speed. On the stationary photographic plate the successive slit images then build up to form a complete image of the sun in the particular wavelength chosen.

The spectro-helioscope embodies the same basic principle, but is adapted to visual observation, an eyepiece taking the place of the photographic plate. The mirrors are arranged so that the second slit is immediately below the first. A square sectioned rod of glass is placed in front of the two slits and spun rapidly; as the rod spins, the light falling on the first slit and transmitted by the second slit, comes from successive portions of the sun's disk in turn. The rotating rod acts, in fact, as a scanning device and the scanning is sufficiently rapid to eliminate flicker and by persistence of vision to enable the observer to see in the eyepiece a built-up picture of the solar surface. The sp ctrohelioscope has proved a valuable instrument for studying phenomena of a transient nature occurring on the sun, such as the bright solar eruptions or "flares", which are responsible for sudden radio fade-outs. By means of a line-shifter, in the form of an interposed glass plate which can be rotated about a vertical axis, the wavelength of the light falling on the second slit can be slightly displaced in either direction, providing a simple and convenient method of measuring line-of-sight motions.

The second instrument for solar observation to which I desire to refer is the coronagraph, developed by Lyot of the Paris Observatory. The sun is surrounded by an extensive faint appendage, termed the corona, whose total light is only about half that of the full moon, or about one-millionth of that of the sun. It is not possible to see the corona under ordinary conditions because its light is so much fainter than the sunlight scattered by the earth's atmosphere. On the moon, where there is no atmosphere, it would be possible to see the corona in full sunlight. Astronomers have had to wait for the few short moments of the total phase of a solar eclipse, when the sun's light is totally obscured by the moon, in order to study the corona. These observations made at infrequent intervals provide little information about the progressive changes of form and structure of the corona. This has now been made possible by Lyot's coronagraph.

The corona has an emission bright-line spectrum. From determinations of its absolute brightness in its various radiations, derived from eclipse observations, it can be concluded that the coronal light is brighter than sky light per Angström unit of spectrum when the air is free from dust and of sufficient rarity. Under these

conditions the atmospheric scattering is greatly reduced. This provides the practical basis for Lyot's design, in which an artificial eclipse of the sun is achieved under conditions in which the troublesome scattered light is reduced to such an extent that the corona becomes visible.

In the coronagraph, the objective forms an image of the sun in the focal place where an occulting disk, slightly larger than the sun's image, is placed. A slightly tilted flat mirror in front of the disk reflects most of the sunlight to one side, where it is trapped. A field lens behind the disk forms an image of the objective on to a camera lens of slightly smaller diameter than this image, thereby cutting out light diffracted at the edge of the objective. The camera lens forms an image of the first image of the sun on to the photographic plate. Various circular diaphragms trap residual scattered light. The optical components are made with great care from selected glass, entirely free from striae and bubbles, and are given the greatest possible perfection of polish, because minute scratches would increase the scattered light. The site for the coronagraph must be carefully chosen, on some suitable mountain and well above the dust line. Lyot's observations have been made on the Pic du Midi, at an altitude of about 9,000 feet.

Lyot has succeeded in seeing the inner corona visually with the coronagraph, photographing it in integrated light, and photographing its spectrum. The outer corona is too faint to be seen with the coronagraph and can be seen only at the time of a total eclipse, but the fairly continuous observations which can be made of the inner corona in clear weather enable its structural changes to be studied. In the ultra-violet, the violet, and the blue, the strong atmospheric diffusion is unfavourable for the coronagraph observations, but under the most favourable conditions accurate measurements of the wave-lengths of the spectral lines in this region have been made. In the red and infra-red region, the coronagraph observations are superior to those made at eclipses; Lyot has discovered several new lines not previously recorded and has determined their wavelengths with accuracy. The observations showed that the various coronal radiations are not all distributed in the same way around the sun. For the study of the differences in distribution, photography of the corona with the light of its various radiations is desirable.

For this purpose, practically monochromatic filters, with high light transmission and having a wide field are required. To meet this need, Lyot has developed a series of filters of a novel type, the principles of which are as follows. The light is passed successively through a series of polarisers, whose planes of polarisation are parallel. Between each polariser and the next is placed a plate of crystal of quartz, or of Iceland spar, cut parallel to the optical axis of the crystal. The faces of the plates are parallel and normal to the incident light; their optical axes are parallel and inclined at 45° to the planes of polarisation of the polarisers. Each plate has a thickness exactly double that of the preceding. Neglecting the effects of dispersion and of the loss of light by reflexion, the vibration of amplitude A which is transmitted by the first polarisers is split up by the thinnest plate into two vibrations at right angles of amplitude $A/\sqrt{2}$, with a difference of phase δ, determined by the thickness of the plate. The second polariser makes these parallel and reduces their amplitude to $A/2$. After the second plate and the third polariser there are four vibrations with retardations 0, δ, 2δ, 3δ, each with amplitude $A/4$. After n plates there are 2^n

vibrations, with retardations o, δ, 2δ, ... $(2^n-1)\delta$, with amplitude $A/2^n$. The spectrum of the light resulting from interference of these vibrations consists of a small number of bands whose amplitude at the centre is A and whose width is $2\lambda/2^n\delta$. The distance between them is λ/δ. On both sides of each band are some weak secondary maxima. Thus it is possible to isolate a narrow band, of the order of only one or two Angström units in breadth, with a high luminous transmission, and the bands on either side of the selected band can be cut out by the use of suitable colour filters. The wavelength of the transmitted band varies with change of temperature, in consequence of the change in thickness of the plates and the change of the refractive index, so that it is essential to control the temperature of the filter thermostatically. It is possible by suitable choice of the temperature to bring the wavelength of the transmitted band into exact agreement with that of a particular coronal radiation.

Lyot made a second filter using polaroid films as polarisers with six plates of quartz, choosing the thickness of the first plate so that six of the monochromatic radiations transmitted by the filter coincided closely with those of four important chromospheric radiations (Hα, D_3 of helium, C of magnesium, and Hβ) and of the red coronal line, 6375A, and the green coronal line, 5303A. By slight diminution of the thickness of the fifth and sixth plates, he was able to obtain transmission of the two coronal radiations for the same temperature of the filter—somewhat different temperatures were required for each of the four chromospheric lines. By some further ingenious modifications, the details of which it is not necessary to describe, he has been able to obtain simultaneous cinematograph records in three colours, the green and red coronal rays and the Hα radiation, of the solar prominences. It has thus been possible to study the changes of coronal structure in two of its most important radiations and simultaneously to photograph the prominences and record their changes. This achievement constitutes one of the most important advances in the technique of solar observation.

It has not been possible for me to do more than indicate some of the main developments in modern astronomical instruments and to describe briefly some of the special instruments that have been or are being developed for particular purposes. Of the technique of observation and the design and use of ancillary equipment, such as spectrographs of high and low dispersion, with or without a slit, correcting lenses, Bowen's image slicer, photo-electric cells and electron multipliers, I have said nothing, as I have felt these matters to be outside the scope of this lecture.

Mr. FAWCETT, in proposing a vote of thanks to the Lecturer, said: The Astronomer Royal has given an extremely interesting lecture, which has covered times past up to the present day, and which shows what an enormous amount of work he has put into the subject. I have learnt much myself, as I am sure we all have.

Mr. G. M. SISSON seconded this, and the vote of thanks was then carried with acclamation.

THE CHAIRMAN, in closing the meeting, said: I am sure we have all enjoyed listening to such a brilliant address, expressing very complex and difficult problems with such knowledge, skill and power. Without understanding all its implications we now have some knowledge of what instruments may do.

After some further applause the meeting then terminated.

CORRESPONDENCE

Educational Facilities in the British Zone of Germany

At Uetze, near Hanover, there are no fewer than seventy children in one class. There is not a single text book for either the use of teacher or pupils. They have neither writing paper nor exercise books.

This case is known personally to me, and is typical of the serious educational difficulties throughout the zone. A special correspondent of "The Times" has reported that, at one school in Lower Saxony, he found a single master trying to teach 141 children with the aid of only one book borrowed from a library!

I therefore gladly take this opportunity of appealing to all fellow members of the Society and their friends to assist in helping these children by forwarding any suitable books which they may have to spare, either in English or German, and including pamphlets of educational value, exercise books, pencils, chalk and any school equipment. Please send these items to The Secretary, German Educational Reconstruction, 15, James Street, London, W.C.2. Please mark your gifts "R.S.A.".

This scheme has the full approval of the Military Government. The Education Branch of the Control Commission are arranging for all gifts to be sorted and allocated by a committee of German educationists at Hamburg. After sorting they are sent to schools in all parts of the British Zone. Having seen these appalling conditions while serving with the R.A.F., I do beg the co-operation of all to assist in providing educational relief.

Germany is culturally isolated, and surely there can be no greater constructive contribution to future European peace than by helping to educate the children of to-day, some of whom will be the leaders of to-morrow.

I shall be glad to supply any further details to those interested.

38, Georgina Road, Beeston, Notts. P. Tussaud-Birt (Ex B.A.O.R.)

GENERAL NOTE

Scottish Art in London.—During the past few weeks those of us who missed the exhibition of Scottish art arranged for the Edinburgh Festival have had an opportunity of visiting a lively display of contemporary Scottish painting at the R.B.A. Galleries in Suffolk Street, which must, unfortunately, be dispersed on the eighth of this month. Nearly eighty oils, water-colours and sculptures have been arranged in one room of the Galleries by the Society of Scottish Artists, which has emerged from its headquarters in Edinburgh for the first time in its history of more than half a century.

Like the New English Art Club (which is appropriately holding its exhibition in the adjacent rooms) the Society of Scottish Artists was founded by a group of young rebel painters as a counterblast to their Academy. Its purpose was, and still is, to encourage youth and experiment, and no member has a prescriptive right to space in the exhibitions. Every work submitted is judged on its merits by a selecting committee, so that an exhibition carries no deadweight of work by members who may have failed to fulfil their earlier promise. The history of the society until recent years is mainly a record of disputes with the uncompromising Scottish Academy; but their interests are now so largely merged that the "rebel" Society holds its Autumn displays on the Academy's walls and a number of prominent artists—such as Mary Armour, W. MacTaggart and D. M. Sutherland—actually belong to both bodies. To-day the Scottish Society's large membership is drawn from all over the country, even from South of the Border; but unquestionably the main strength of the Society is in the group of Edinburgh artists and in such distinguished members of the Glasgow School as John Miller, Ian Fleming and the Armours.

It is a pity that on the occasion of their first London visit there was not sufficient space for the Society to hold an exhibition comparable in scope with their Jubilee Exhibition in 1944. But if the few carvings are insufficient to judge the impressive work of such sculptors as Pilkington Jackson and Thomas Whalen, there are enough canvases at the R.B.A. to indicate clearly the salient characteristics of Scottish painting to-day—richness of colour, and breadth and rhythm of pattern.

Among the more memorable works in the exhibition I would single out Henderson Blyth's "War Baby, 1918"—a portrait of a wounded infantryman, as striking as any of

Orpen's war records—, MacTaggart's imaginative "Glimpse of the Forth", painted largely with the knife, Ian Fleming's water-colour "Aftermath, the Rhine", and a remarkable study of "Edinburgh Tenements", somewhat akin to Nevinson in feeling, by Kathleen Horsman.

In conclusion, I would commend to the notice of the contemporary art society—before the pictures are returned to Scotland—D. M. Sutherland's sparkling "Plockton Regatta" and Mary Armour's "Summer View on the Moor". N. A. D. WALLIS.

OBITUARY

SIR ALBERT HOWARD, C.I.E., F.L.S.—We regret to announce the death on October 20th of Sir Albert Howard who had been a Life Fellow of the Society since 1933. Sir Albert will be chiefly remembered by Fellows as a distinguished lecturer to the Society and for the frequent and active part he used to take before the war in meetings of the Society concerned with agriculture and agricultural problems. There is still a steady demand for his two papers to the Society on "The Waste Products of Agriculture" in 1933 and on the "Manufacture of Humus by the Indore Process," which even now are the standard works on this subject. Sir Albert, after his retirement, devoted himself with passionate zeal to advocating the value of natural organic fertilisers in the growing of healthy crops, and he was in touch with agriculturists in all parts of the world who were experimenting with great success with his Indore process.

He was born in 1873, and educated at the Royal College of Science and St. John's College, Cambridge. After short spells in the Imperial Agricultural Department for the West Indies and as Botanist at the South Eastern Agricultural College, Wye, Sir Albert went, in 1905, as Imperial Economic Botanist to the Government of India. He held this post until 1924, when he became, for seven years, Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to states in Central India and Rajputana, and it was here that he developed the Indore Process of humus manufacture. Howard was knighted in 1934.

SOME MEETINGS OF OTHER SOCIETIES DURING THE ENSUING FORTNIGHT

TUESDAY, NOVEMBER 11..Chemical Engineers, Institution of, at the Geological Society, W.1. 5.30 p.m. T. A. Hall and G. G. Haselden, **"The Purification of Gases in Low Temperature Processes."**

Electrical Engineers, Institution of, W.C.2. 5.30 p.m. Wing Commander P. Allerston, **"What Equipment is Necessary for the Servicing and Testing of Electronic Devices."**

Illuminating Engineering Society, at 2 Savoy Hill, W.C.2. 6 p.m. F. Widnall, **"The Design of Industrial Lighting Equipment."**

WEDNESDAY, NOVEMBER 12..Electrical Engineers Institution of, W.C.2. 5.30 p.m. W. H. L. Lythgoe, **"Standardization of Power Cables."**

Kinematograph Society, British, at Film House, Wardour Street, W.1. 7.15 p.m. G. I. P. Levenson **"Controlling the Elon-Hydroquinone Developer."**

Petroleum, Institute of, 26 Portland Place, W.1. 5.30 p.m. R. N. J. Saal, **"Rheological Investigation of Asphaltic Bitumen in Connexion with its Technical Application."**

Sanitary Institute, Royal, 90 Buckingham Palace Road, S.W.1. 2.30 p.m. F. C. Vokes, **"The Future Sewage Disposal Works of the Birmingham Tame and Rea District Drainage Board—A Forecast."**

THURSDAY, NOVEMBER 13..Asiatic Society, Royal, 56 Queen AnneStret, W.1. 4.30 p.m. G. A. Kincaid **"The Ancient Legends of Sind."**

Chemical Society, at the North British Station Hotel, **Edinburgh.** 7.30 p.m. Dr. Philip Eggleton, **"Diffusion in Biological Processes."**

Electrical Engineers, Institution of, W.C.2. 5.30 p.m. G. V. Sadler, **"Electrical Aspects of Overhead Travelling Cranes."**

Photographic Society, Royal, 16 Princes' Gate, S.W.7. 7 p.m. E. W. H. Selwyn, **"Photographic Resolving Power of Lenses."**

Physical Society, at the Imperial College of Science, S.W.7. 4 p.m. J. M. M. Pinkerton, **"Supersonic Absorption in Liquids."**

Royal Society, W.1. 4.30 p.m. (1) A. V. Hill, **"The Resolution of Physical and Chemical Events in Muscular Contraction."** (2) R. M. Davies, **"A Critical Study of the Hopkinson Pressure Bar."**

FRIDAY, NOVEMBER 14..Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. (1) H. E. Rose **"The Mechanical Differential Analyser."** (2) S. C. Redshaw, **"An Electrical Potential Analyser."**

North East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, **Newcastle-on-Tyne.** 6.15 p.m. E. J. Hunter, **"Ship-Grafting - Certain War-Time Ship Repairs."**

Royal Institution, W.1. 9 p.m. A. L. Rowse, **"The Elizabethan Age."**

TUESDAY, NOVEMBER 18..Architects, Royal Institue of British, W.1. 6 p.m. G. Grenfell Baines and Tom Mellor, **"Substitute Materials and their Influence on Design."**

Chadwick Trust, at the Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1. G. A. R. Sheppard, **"Modern Trends in Waterworks Practice."**

Chemical Engineering Group, at the Chemical Society W.1. 5.30 p.m. P. M. Schuftan, **"A New Process for the separation of Ethylene from Coke Oven Gas."**

Eugenics Society, at the Royal Society, W.1. 5.30 p.m. G. C. L. Bertram, **"Eugenics, Population Trends and the World's Resources."**

WEDNESDAY, NOVEMBER 19..Electrical Engineers, Institution of, W.C.2. 5.30 p.m. H. A. H. Boot, and Professor J. T. Randall, **"The Cavity Magnetron."**

THURSDAY, NOVEMBER 20..Chemical Society, at the University, **Liverpool.** 4.30 p.m. Professor H. W. Melville, **"The Chemistry of Ethylenic Polymers."**

Electrical Engineers, Institution of, W.C.2. 5.30 p.m Sir Arthur Fleming, **"The Practical Training of Professional Electrical Engineers."**

Town and Country Planning Association 28 King Street, W.C.2. 1.15 p.m. H. Edward Newman, **"The Internal Planning of the Home."**

FRIDAY, NOVEMBER 21..Chemical Society, at the Royal Technical College, **Glasgow.** 7.15 p.m. Professor M. G. Evans, **"Electron Transfer Reactions."**

Electrical Engineers, Institution of, W.C.2. 5.30 p.m. Professor J. Greig, and H. Kavser, **"Iron-Loss Measurement by A. C. Bridge and Calorimeter."**

Geographical Society, Royal, S.W.7. 5.30 p.m. R. F. Hansford **"Radio Aids to Navigation."**

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. Sir Alwyn Crow, **"The Rocket as a Weapon of War in the British Forces."**

Royal Institution, W.1. 9 p.m. Dr. C. H. Desch **"Recent Developments in the Steel Industry."**

Sound Recording Association, British, at the Royal Society of Arts, W.C.2. 7 p.m. M. G. Scroggie **"What is High Quality Reproduction."**

SUNDAY, NOVEMBER 23..Kinematograph Society, British, at Film House, Wardour Street, W.1. 11 a.m. W. D. Wright, **"Fundamentals of Colour."**

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